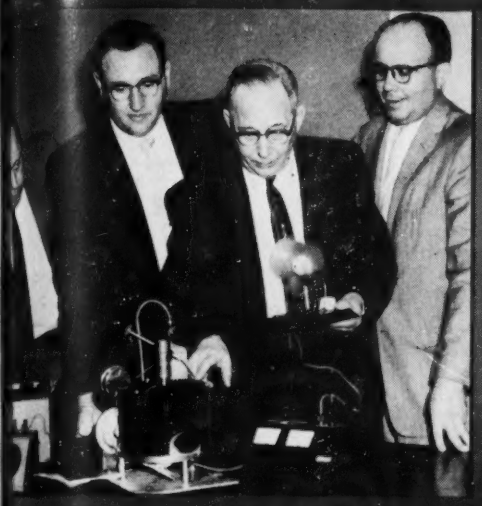
MARCH 1960



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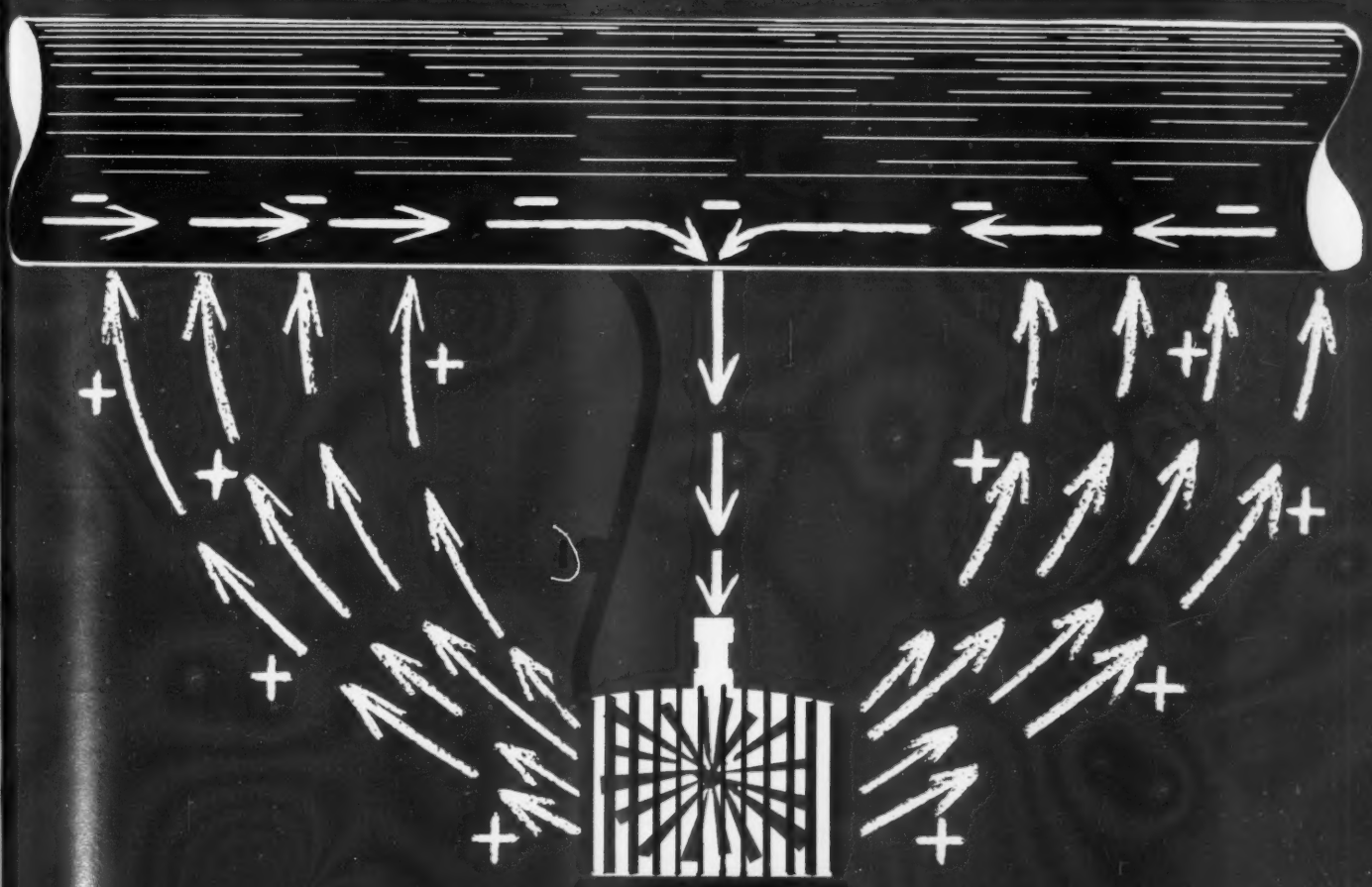

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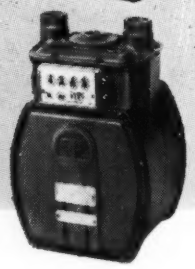

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PILOT.. ..LIGHTS

Industrial Gas Meter Reading by Telephone
USES BELL SYSTEM DATA PHONE EQUIPMENT TO TRANSMIT DATA FROM METER OVER VOICE

Dial "M" For Meter Reading

Read meters by telephone? Why not? Earl Tornquist, research engineer for Northern Illinois Gas Company, the man in the photo above, is doing just that. Tornquist and associates are currently working on a system of reading industrial gas meters simply by dialing the telephone meter assigned to the gas meter to be read and pushing buttons. The reading can be obtained several ways — visually or printed-out. Equipment for converting the reading into a coded signal was developed by the gas company research department. The data is transmitted over regular telephone company voice lines using Bell System's "Data Phone" equipment. In the April issue, the how and why of this new approach to remote m reading will be discussed at length.

All About Aquifer Storage

An ideal way to cut the expense of peak shaving is to buy gas during the summer months — when demand is normally low — and shove it into underground storage for use during high demand periods in winter. For many gas utilities, the problem is not so simple; depleted oil and/or gas fields may not be close by or even exist. What to do? Look for aquifer storage in the utility's service area. Aquifers — what they are, how to find them, how to develop them, and how to use them will be the subject of a four-part series beginning next month in AGJ.

American Gas Journal

ONLY MAGAZINE EDITED EXCLUSIVELY FOR THE GAS DISTRIBUTION INDUSTRY

Volume 187 March 1960 Number 3

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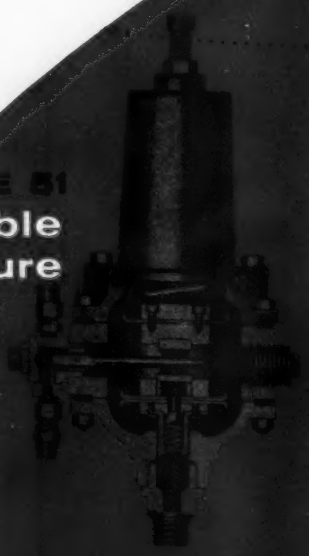

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NEWS HILITES OF THE INDUSTRY

FPC Commissioner William R. Connole continues to plug for a "national fuels policy." Speaking in Washington before the Electric Consumers Information Committee, Connole said he had "long recognized the fatal lack of an energy policy . . . and the need for some study to develop one . . ." and that he was "encouraged" by the creation of the National Coal Policy Conference by the coal industry *(a group that is also advocating a national fuels policy)*. Connole said that the energy policy that he envisions "should have as its bedrock foundation the idea that energy must cost the user as little as possible." Other considerations on the "costs" angle mentioned were in terms of "national defense" and "dislocations" among the several fuels industries.
An "All-Oil" home? It's possible, say the Oil Heat Institute of America, to have a completely oil-powered home . . . and it's closer than most people realize. Half the cost of electricity is in getting the power from the generating point to the home, Fred Heaney, OHIA president told a press conference, and with a low-powered, oil-fired turbine to turn a home generator, users would be able to save significantly on the cost of electrical power. Thus a homeowner equipped with an "oil-powered" house wouldn't have to worry about severe storms and "other phenomena" that might cause pipeline or power failures. An adequate energy supply could be stored on the users premises, he said. *(No home should be without a 1000-bbl oil tank in the backyard — Ed.'s Note.)*

There's no reason to deny natural gas service to an area "simply because it will offer competition to an existing fuel and there will be some displacement of the existing fuel by reason of the public demand for natural gas" noted the FPC in deciding for a second time that Blue Ridge Gas Company of Harrisonburg, Virginia, could buy 2,000,000 cu ft per day from Atlantic Seaboard Corporation. Approved once in Blue Ridge's favor, the case was remanded by a U. S. Court of Appeals because the FPC didn't permit a group of petroleum jobbers to intervene. The oil jobbers had their say the second time, but the commission said it was unable to find that their exceptions raised any material issues not previously fully argued before the examiner and properly disposed of by him in his decision.

Imitation is the sincerest form of flattery. Now being advertised around the nation is a new "electric light bulb with gas flame charm," the Hammacher Schlemmer duro-lite. It is, in the words of the electric industry, a "new concept in lighting decor." And, adds the copywriter, "this revolutionary new light bulb is a miracle of 'gas flame' enchantment."

Natural gas exchange between Oklahoma Natural Gas Company and Consolidated Gas Utilities Corporation, all within the state of Oklahoma, probably won't ever take place as result of a new FPC interpretation of what is and what isn't "interstate" movement of gas. ONG wanted to buy 6,000,000 cu ft per day from CGU for its Clinton, Oklahoma, system. In turn, it would deliver an equal volume to CGU near Enid, Oklahoma. In applying to the FPC, ONG requested exemption from the Natural Gas Act so it could exchange the natural gas without being subject to FPC jurisdiction. No dice, said FPC. The ONG gas would commingle in Consolidated's pipeline and some of it was destined to cross a state line and that would make it interstate gas, and even though it was a good deal for all concerned, the commission just couldn't approve it. Commissioner Arthur Kline dissented from the majority opinion and noted that the action taken was a "complete reversal" of the position assumed by the FPC in all previous similar instances. Kline noted that the FPC, under the present law, had no jurisdiction over such sales and that it was up to Congress, not the FPC, to determine such jurisdiction.

AMERICAN GAS JOURNAL, March 1960, Vol. 187, No. 3. Published monthly except August, then semi-monthly by The Petroleum Engineer Publishing Company, P. O. Box 1589, Dallas, Texas. Second class mail privileges authorized at Dallas, Texas. Executive and Editorial Offices at 800 Davis Building, P. O. Box 1589, Dallas 21, Texas.

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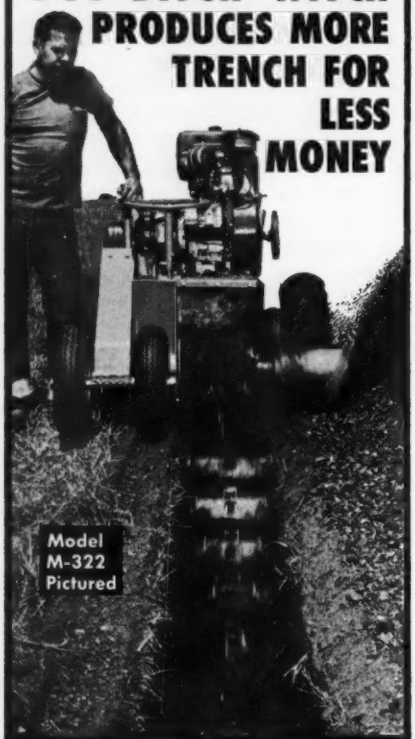
Other trenchers cost "More or Less"
Other trenchers dig "More or Less"
BUT DITCH WITCH PRODUCES MORE TRENCH FOR LESS MONEY



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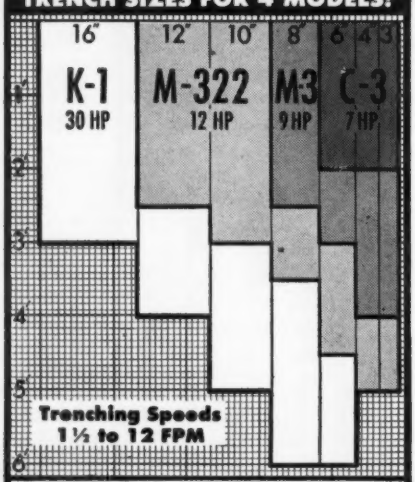

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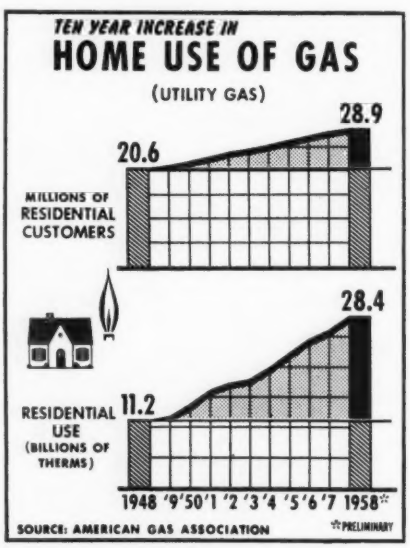
Gas supplied by Southern Union Gas Co. will be used to both cool and heat the tallest building in New Mexico—a 14-story Bank of New Mexico Building now under construction in Albuquerque, New Mexico. Featuring the most advanced architectural design and engineering concepts, the entire structure will be cooled by a single 300-ton steam-powered absorption unit manufactured by The Trane Company. Located on the roof, the equipment will use low pressure steam generated by natural gas to produce chilled water for air conditioning purposes. When operating at maximum capacity, unit will provide cooling power equivalent to that furnished by 600,000 lb of ice melting in 24 hours.

Members of the planning staff working on the electronic data processing system to be installed by The Gas Service Company, of Kansas City, Missouri, have completed their schooling at the International Business Machines and are continuing with the preliminary plans for installation of the equipment. At the initial 7-week school, staff members studied the various types of machines that will be used by the company, wiring of the machines, card designs and layouts, and basic machine maintenance. A second 2-week school on programming of electronic computer was attended by three members of the staff—Gene T. Waters, Jack Wilkinson, and Richard Pearson. Surveys to determine the method of accounting and billing at the various company's properties are nearing completion. Information obtained in these surveys will be evaluated and a standardized method of operation set up which will be adaptable to the machines.

August in March. Under the marquee of the Carlton House, one of Pittsburgh's largest hotels, five gas-fired infra-red heaters chase chills from guests waiting for taxis and limousines. At left, Richard Conover, Equitable Gas Company's general promotion manager, holds thermometer showing temperature outside marquee. Comfortable 70 F under the heaters is indicated on the other thermometer. At right is J. S. Schuchert, Equitable vice president in charge of sales. The two lovely lasses are unidentified.

NEWSREEL



An average of 830,000 new residential customers a year have been added by gas distribution companies during the past decade to bring a total increase of 40 percent in use of gas since 1948. Annual home use of gas has climbed to more than 28 billion therms as a result of steadily increasing demands for gas house-heating and other modern gas appliances.

Instructors and students in hotel and restaurant education courses are being offered extensive technical assistance by the firms that manufacture gas equipment for hotel and restaurant use. A directory of the manufacturers of commercial gas cooking appliances and a list of their products have been mailed to schools and colleges offering training in the hotel and restaurant industries. The list, compiled by Gas Appliance Manufacturers Association, includes 29 companies, members of GAMA's commercial gas equipment division who have volunteered technical assistance on request from accredited students or instructors.

ELIZABETHTOWN CONSOLIDATED GAS COMPANY of Elizabeth, New Jersey, makes sure that its stockholders are aware of the importance of using gas in their homes, businesses, and industrial plants. On the front of its quarterly income statements mailed to stockholders appears this comment:

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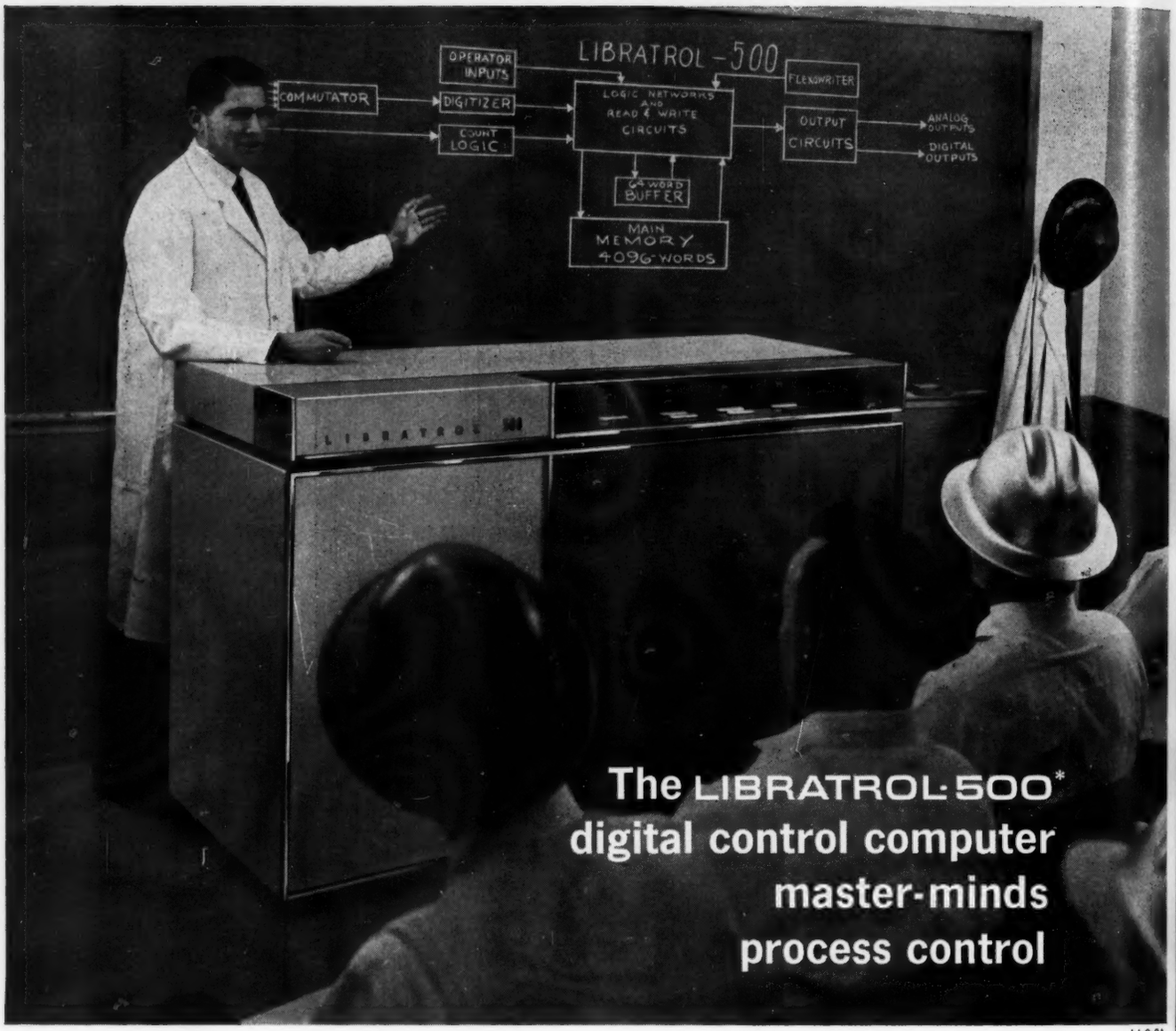

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■ Even more than a monitoring, computer-directing, and controlling system ... the Libratrol-500 can actually teach industry about its own processes ... can help to establish basic operating criteria.

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■ *The Libratrol-500 is a high-speed digital computer-controller designed to handle:*

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3. Rapid computation of control loop functions while handling on-line decisions and control. On one current installation, the Libratrol-500 completes a recurring calculation in one minute ... a problem formerly requiring 45 minutes computation by two engineers.

■ *A wide range of input-output equipment can be accommodated by the Libratrol-500, making the system especially suitable for pipeline automation, petroleum and chemical plants, iron and steel mills, gas and electric utility plants.*

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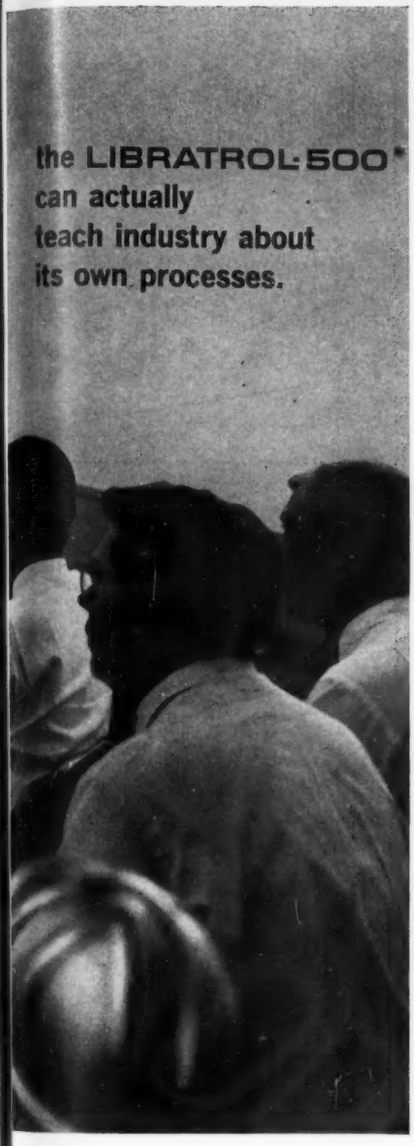
■ The Libratrol-500 is typical of Librascope's leadership in creating new computer concepts ... a 22-year leadership based on uncovering needs and meeting them with advanced designs, reliable computing systems.



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PHILADELPHIA GAS WORKS, Division of The United Gas Improvement Company, unveiled a new emblem in the September issue of *PGW News,* company magazine. The new insignia replaces all other emblems and will appear on company vehicles, letterheads, printed customer communications, advertisements and elsewhere. It symbolizes unity with the City of Philadelphia by the connected letters and traditional City colors of blue and gold; PGW's unity with the gas industry is indicated through use of the A.G.A.-sponsored blue flame in the center. The simple "blue flame" in use since 1956 and the familiar seal known as a "scrambled egg," a company emblem dating back to 1933, have been relegated to the history books. The new emblem was designed by Charles R. DeHaven, manager of public relations.

IN ITS FINAL SUMMARY OF 1958 STATISTICAL STUDIES, the American Gas Association reports net income of gas distribution and transmission companies advanced to an all-time high of $692,000,000 — a 6.8 percent gain from the $648,000,000 recorded in 1957. Income of utility companies alone totaled $440,000,000. Total operating income from all sources advanced to $7,106,000,000 — up 10.8 percent. Utility operating income of $922,000,000 was up 9.5 percent, while net plant increased in value from $13,295,000,000 in 1957 to $14,255,000,000 last year. The relationship between utility operating income and net utility plant (the largest factor used in determining the rate base) indicates an approximate return of 6.5 percent, up from 6.3 percent a year earlier. Interest rates were generally lower than in 1957. New preferred stock issues of straight gas companies cost 5.47 percent, compared with 5.78 percent in 1957, bond money cost 4.95 percent down from 5.06 percent, and debentures sold at an average interest rate of 4.78 percent, down from 5.37 percent a year earlier. Revenues from sales to ultimate customers increased 10.5 percent above 1957 levels, to establish a new all-time high. The industry served an average of 31,200,000 customers in 1958 compared with the 1957 average of 30,500,000.

PEOPLES NATURAL GAS COMPANY'S new trademark designed by Lester Beall, a prominent graphics designer in New York City, artistically expresses the progressive character of the gas industry. The new symbol consists of two integral elements, a flame and an earth unit, and now appears on Peoples Gas Service trucks and other mobile equipment, and shoulder patches on Peoples Gas meter readers and servicemen. Company letterheads, line markers, office signs, customer bills, and other items associated with Peoples Gas and its parent organization, Consolidated Natural Gas Company, will also feature the symbol. The flame symbolizes gas as it emerges originally from the earth, as well as the underground storage of gas in depleted gas fields. The sharply defined overall design, clean-cut against sizeable areas of white space, dramatizes the cleanliness and modernity of natural gas.

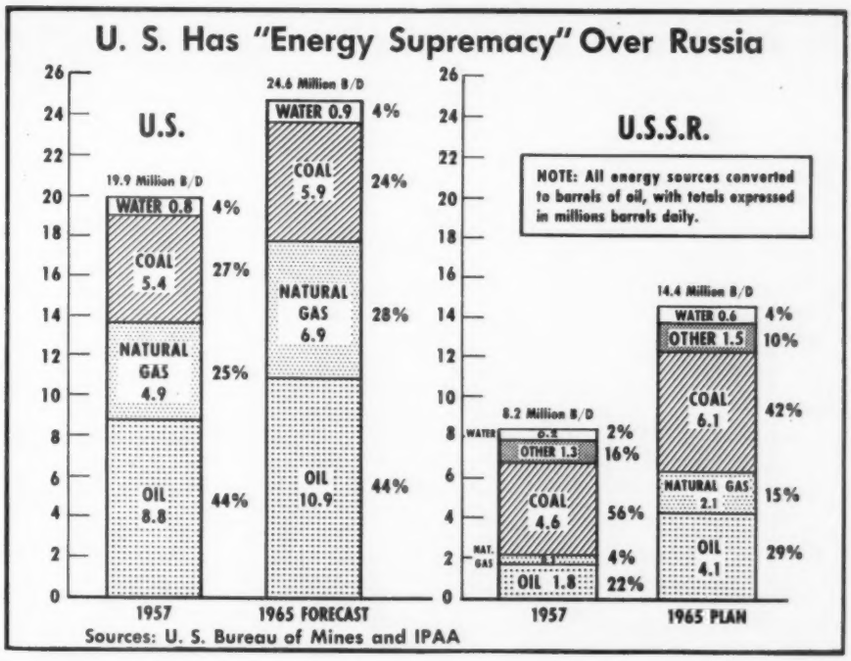

Chart compares American and Soviet energy production, and projects the comparison to 1965. Russia is second to the U. S. in total energy output, but is behind at least a dozen Free World countries in per capita energy use. The Soviet recently announced a vast new program to expand energy output with a 1965 goal of 14.4 million barrels daily. Despite these programs, America can maintain "energy supremacy" for the foreseeable future, says the Independent Petroleum Association of America. Petroleum fuels, oil, and natural gas, provided 69 percent of U. S. energy needs in 1957, and by 1965 will be filling 72 percent of our requirements.

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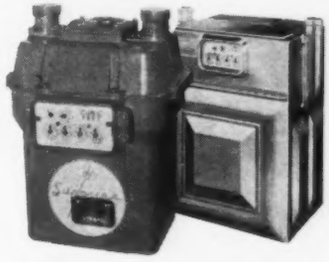

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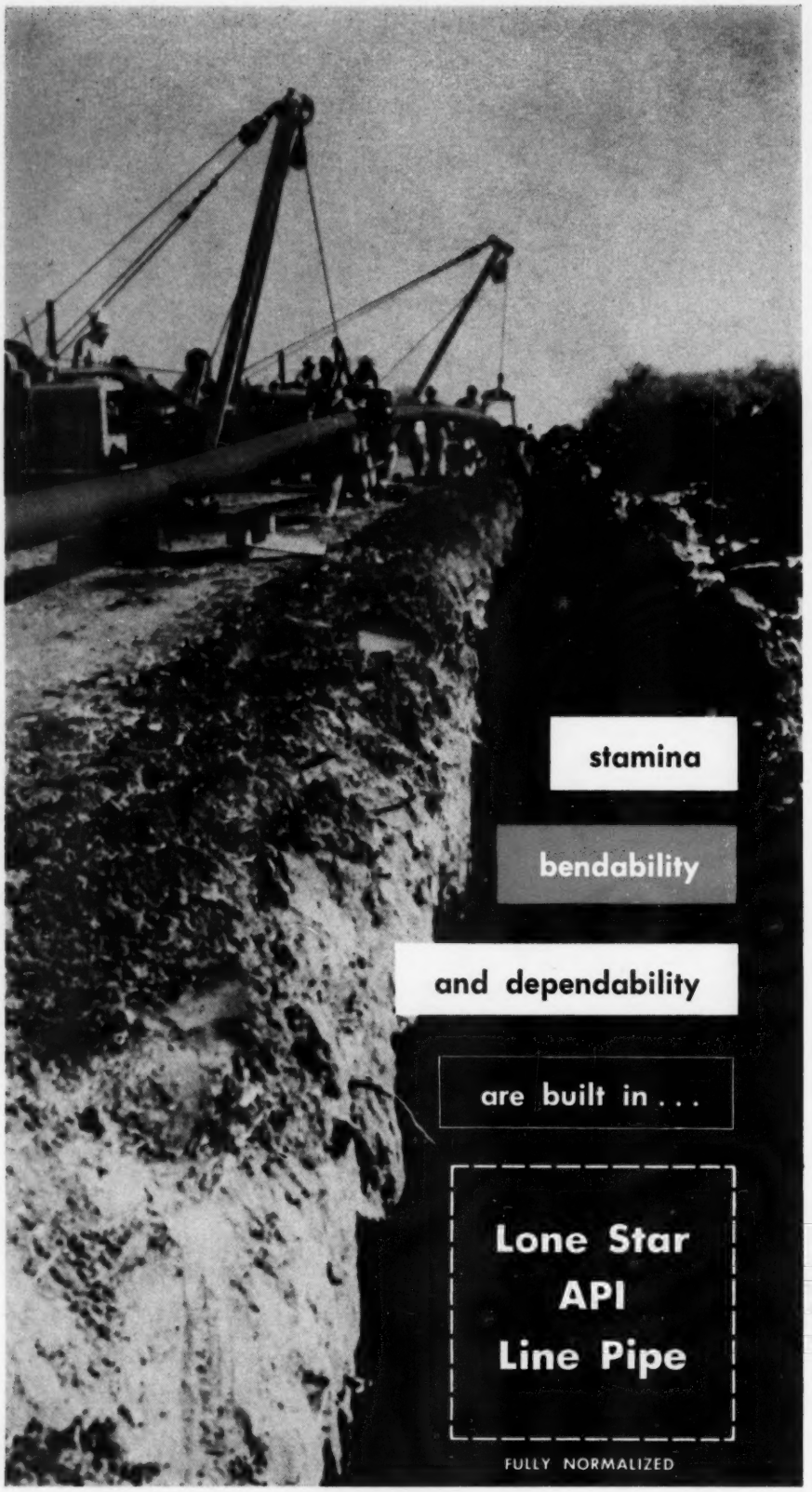

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COMING EVENTS IN THE GAS DISTRIBUTION INDUSTRY

March

14-18 National Association of Corrosion Engineers, annual convention, Dallas, Texas.
21-23 Mid-West Gas Association, annual meeting and convention, Hotel St. Paul, St. Paul, Minnesota.
23 Oklahoma Utilities Association, accounting section, Biltmore Hotel, Oklahoma City, Oklahoma.
24-25 Oklahoma Utilities Association, annual convention, Biltmore Hotel, Oklahoma City, Oklahoma.
24-25 NEGA annual meeting, Hotel Statler, Boston, Massachusetts.
29-31 ASME American Power Conference, Sherman Hotel, Chicago, Illinois.
30-April 1 GAMA annual meeting, The Greenbrier, White Sulphur Springs, West Virginia.

April

5- 7 A.G.A. sales conference on industrial and commercial gas, The Shamrock Hilton, Houston, Texas.
8-9 Florida-Georgia Gas Association, annual convention, Biltmore Hotel, Palm Beach, Florida.
19-21 Southwestern Gas Measurement Short Course, University of Oklahoma, North Campus, Norman, Oklahoma.
19-21 A.G.A. Research & Utilization Conference, Hotel Carter, Cleveland, Ohio.
21-22 Indiana Gas Association, French Lick-Sheraton Hotel, French Lick, Indiana.
25-27 A.G.A.-EEI National Conference of Electric and Gas Utility Accountants, Roosevelt & Commodore hotels, New York City.
25-27 Southern Gas Association, annual convention, Galveston, Texas.
25-29 American Welding Society, 41st annual convention, Biltmore Hotel, Los Angeles, California.
27-29 NACE Portland Section Corrosion Control Short Course, Portland, Ore.
28-29 Pacific Coast Gas Association Distribution Conference, Benson Hotel, Portland, Oregon.

May

9-12 National Restaurant Show, Navy Pier, Chicago, Illinois.
9-13 ISA instrument-automation conference, San Francisco, California.
9-13 A.G.A. Operating Section Joint Distribution and Transmission Conference, Hotels Roosevelt and Jung, New Orleans, Louisiana.
12-13 A.G.A. eastern gas sales conference, Statler Hotel, Washington, D. C.
16-18 A.G.A. mid-west regional gas sales conference, Edgewater Beach Hotel, Chicago, Illinois.
16-20 National Fire Protection Association, annual meeting, Montreal, Canada.
22-26 ASME, Oil & Gas Power Conference, Muehlebach Hotel, Kansas City, Missouri.
23-25 A.G.A. Operating Section Production Conference, Hotel Roosevelt, New York, New York.
24-26 Pennsylvania Gas Association, annual meeting, Pocono Manor, Pennsylvania.

Why drill services?
PUNCH 'em!

Four small guides which hold punch to its true axis.

A new way for taking services off mains. A quick, safe welding tee that incorporates in each tee a punch and positive shut-off... doing away entirely with the use of drill devices. Punch size, 3/8" or smaller.

We also have a model for use with saddles, threaded at the base to screw into the saddle.

Each tee is tested to 5,000 p.s.i. hydraulic pressure, and carries "Rated 1,000 pounds". A 5 to 1 safety factor. A real high pressure tee. Made from steel similar to pipe, it welds easily, and in the saddle model, takes a perfect thread.

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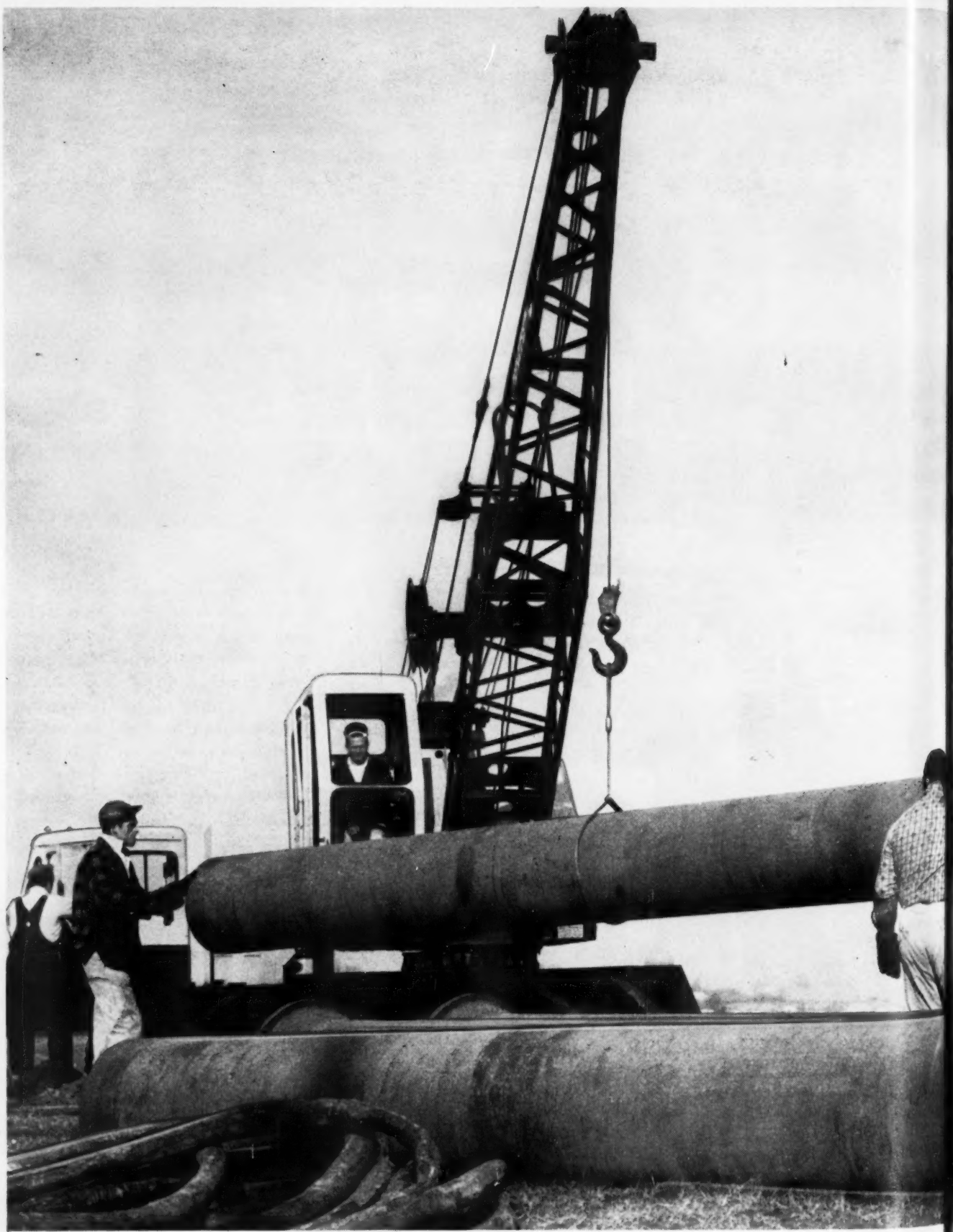
With this tee you will be forever free from the cost of drilling machines, broken drills and drill machine maintenance and repairs. We feel this tee is the finest service improvement ever offered to the gas industry. Write for circular with installation instructions.

M. B. SKINNER CO.
SOUTH BEND 21, INDIANA

SKINNER-SEAL PUNCH-IT TEE



THE MARK OF THE 100-YEAR PIPE

IF YOUR DECISION MUST STAND UP FOR 100 YEARS...

Rely on cast iron pipe. Gas utility executives throughout the country know they can depend on cast iron pipe. Here's why:

- Cast iron pipe is inherently rugged; its tough construction offers service-free efficiency for years.
- Once cast iron pipe is in the ground, *it stays there!* Forty-five American cities are still using cast iron gas mains that were installed over a century ago.
- Modern mechanical joints remain tight under normal distribution pressures.
- Cast iron pipe withstands all the usual stresses to which underground pipe is normally subjected.

Save—with cast iron pipe

Although original estimates might indicate that other pipe is initially cheaper than cast iron pipe, there are other considerations! Cast iron pipe's durability and corrosion-free service make for *real* savings over the years!

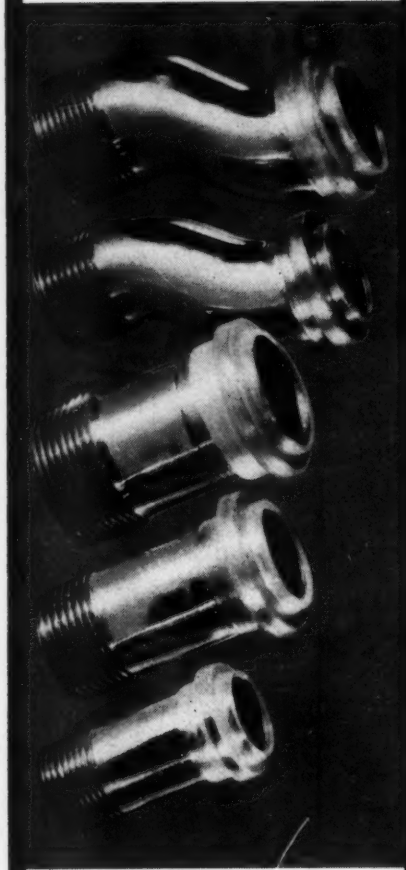
Cast Iron Pipe Research Association, Thos. F. Wolfe,
Managing Director, 3440 Prudential Plaza
Chicago 1, Illinois

...good reasons for you to choose

CAST IRON PIPE

AMERICAN®

insulated meter connections



permanent molded-on design simplifies assembly

- Insulation covers pilot flange and extends up the body—minimizes possibility of short circuits caused by moisture. No loose parts.
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- Insulated meter connections are interchangeable with standard connections—accepts standard caps and washers. Reduces inventory problems.

Ask your American representative for Bulletin 308 describing all insulated and standard meter connections.

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MEN AT WORK

IN THE GAS DISTRIBUTION INDUSTRY

● **James E. Coleman,** vice president-general manager of Manufacturers Light & Heat Co., Pittsburgh, has been elected president of the Pennsylvania Natural Gas Men's Association, succeeding **D. B. Beecher,** president of Equitable Gas Co. of Pittsburgh. Others elected to association offices were **R. L. Ehrman,** vice president and **P. L. Kesel,** secretary-treasurer. Ehrman is vice president of T. W. Phillips Gas & Oil Co., and Kesel is secretary-treasurer of Carnegie Natural Gas Co. **J. B. Sayers,** chief counsel for Peoples Natural Gas Co., has been elected an association director.

J. E. Coleman

G. R. Corcoran

● **George R. Corcoran** has been appointed manager of advertising for the American Car and Foundry Division of ACF Industries, Inc. and will be responsible for advertising, public relations, sales promotion, and industrial exhibits for the division's products.

● Barber-Greene Co. has announced a reorganization of their field sales management with the appointment of **Kent Shell** as regional sales manager for the eastern division, and **Ralph Dano,** regional sales manager for the western division. A new field sales manager has also been appointed, **Tom Benbow,** to supervise all B-G district sales managers and the training of field engineers.

● **Remick McDowell,** president-elect, The Peoples Gas Light and Coke Co., has accepted the chairmanship of the Chicago Business Division, American Cancer Society, Illinois division for the 1960 Cancer Crusade.

Remick McDowell

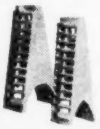
R. J. Plank

● **Richard J. Plank** has been elected a director of Consolidated Natural Gas Co. and named president of New York State Natural Gas Corp. of Pittsburgh, a Consolidated system subsidiary. He succeeds **Fenton H. Finn,** who is retiring from corporate management to become a consultant on matters of gas production and storage. Finn is being retained to work on production and storage problems of all Consolidated system companies. Plank has just recently been elected executive vice president and a director of New York Natural.

EVERYONE'S A CUSTOMER FOR A **DEARBORN**

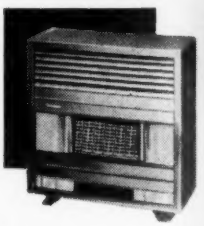
"Boy! Just look at those radiants!"

Of course . . . everyone is a customer for a Dearborn gas area heater. One of the big reasons is the Glo-Brite Radiants, which is referred to by our friend in the row boat. The widely acclaimed quality of Dearborn heaters is built to last, offering years of trouble-free comfort and warmth for your customers. Smart and stylish design coupled with the industry's most advanced engineering make Dearborn the best line of heaters for you to sell!



GLO-BRITE RADIANTS

Glowing cherry red from top to bottom, these radiants put a carpet of infra-red rays across the floor, guarantee positive floor warmth! Standard on all Dearborn Regency models.



The Dearborn Regency is the world's finest gas area heater. Lower, longer and loaded with *sell-on-sight* appeal!

Dearborn®

Get details of Dearborn's clean-cut selling policy from any of these regional sales offices: Atlanta, Chicago, Dallas, Los Angeles, San Francisco.

1960 Dearborn Stove Co., Dallas

R. L. McChain

D. S. Permar

● Le Roi Division, Westinghouse Air Brake Co., has announced a reorganization of its sales department to emphasize selling by markets rather than by product lines. **R. L. McChain,** aided by assistant managers **C. L. Meigs** and **N. W. Reinker,** will head the construction and mining industry sales group. **D. S. Permar,** aided by **E. R. Couch,** assistant manager, will head the general industrial sales group. He will also continue as assistant general sales manager.

● **Edward L. Falls, Jr.,** has been promoted to executive assistant to the general manager of Motorola's communications division. Formerly as a vice president of Motorola Communications & Electronics, Inc., a wholly-owned subsidiary of Motorola, Falls has been managing sales and service of radio communications products in the southern states. In his new post with the parent company, he assumes responsibility for division's new products program that includes closed circuit television and radio traffic control equipment. Succeeding Falls in the subsidiary is **Robert N. Swift,** formerly vice president and manager of the midwest sales area. **Robert F. Davis,** former two-way radio sales manager for the midwest, succeeds Swift.

● **Paul Duke** has been elected vice president and director of L. B. Foster Co., national supplier of steel pipe. He was formerly manager of the Atlanta regional office and under his direction the company operations in the Southeast expanded rapidly especially in heavy construction and in supplying pipe for natural gas distribution lines.

Paul Duke

E. C. Hemes

● **Edward C. Hemes** has been elected vice president of Reeves Brothers, Inc. Formerly a superintendent of measurement with Milwaukee Gas Light Co., he later became executive vice president of Vulcan Rubber Products, Inc. which pioneered synthetic diaphragms for gas meters and regulators, and subsequently joined Reeves Brothers in 1953 when Vulcan Rubber was acquired by Reeves. **James R. Cooper,** former product manager for Vulcan offset and newspaper blankets, has been named general sales manager of Vulcan Rubber Products Division. **Walter A. McEvilly,** former sales representative, succeeds Cooper as product manager, at Reeves' headquarters in New York.

LOW PROFILE...you see
HIGH CLEARANCE...you go!

An impossible combination? Not at all! On Allis-Chalmers utility tractors, the compact, frill-free design keeps the top line low to let operators see where they're working. The engine and axles are high to give you more than 21-in. clearance under a D-14 front axle! You move free and easy over rough or soft ground on any project!

This is the kind of practical engineering—real payoff design—you'll find in Allis-Chalmers utility tractors. Get the facts for comparison, free for the price of a post card! Use the handy coupon below *today!*

D-10 • D-12 • D-14 • D-17

Utility tractors from 31 to 63 engine horsepower with companion equipment to match your needs!

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Utility Tractors & Equipment, Milwaukee 1, Wisconsin

Please send me more information about Allis-Chalmers utility tractors with ☐ backhoe ☐ loader ☐ fork lift

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GAS EQUIPMENT MANUFACTURERS GROUP
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GAS is 7 ways better for the big household services
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They sell Gas and Gas Appliances in GEM National Advertising.

Members of GEM – the Gas Equipment Manufacturers group – underwrite an advertising program in Better Homes and Gardens, Home Modernizing and New Homes Guide. To help the entire industry grow and prosper, they sell homeowners on the comfort and convenience of GAS.

BULLETIN BOARD

FREE 36-page handbook for engineers on the use of Kraloy PVC plastic pipe, fittings, and valves is now available from Kraloy Plastic Pipe Company. Specification, design, and installation information is included as well as a comprehensive corrosion resistance comparison chart for 7 types of plastic pipe carrying 162 chemicals. Other charts show maximum operating pressures for PVC pipe at various temperatures, friction loss characteristics of the flow of natural gas through PVC pipe showing pressure drop in psi per 1000 ft of PVC pipe.

CIRCLE (1) ON THE REPLY CARD

NEW MANUAL OUTLINES PROCEDURE IN MICROFILMING of all engineering drawings. The Filmsort Company, a division of Minnesota Mining and Manufacturing Company, has recently reprinted from its company publication, *Filmsort Facts*, an 8-page illustrated manual that details how the Air Materiel Command of the U. S. Air Force has converted engineering drawings and data to microfilm mounted in aperture cards. Manual is of prime importance to all Air Force contractors since new contracts require submission of engineering data on microfilm and punch cards.

CIRCLE (2) ON THE REPLY CARD

CONDENSED CATALOG of Reynolds Gas Regulator Company's entire line of gas regulators is now available. The 24-page illustrated catalog, first of its kind to be issued by Reynolds, provides a brief informative summary of Reynolds gas regulators, ranging from outdoor gas light and house service regulators to larger equipment, including pilot loaded, monitoring, and district station regulators. Reynolds tools and equipment, ranging from orifice wrenches to pit boxes and test stands, are also included.

CIRCLE (3) ON THE REPLY CARD

PERFORMANCE CAPABILITIES and features of the W-10 Terraload'r are described in a new 16-page, 3-color catalog from J. I. Case Co. Both operation and construction of the 6500-lb-capacity rubber-tired tractor shovel are described. The 4-wheel drive, rear-wheel steer unit features full-power shift and torque converter drive. A choice of SAE rated buckets from 1¼ to 2⅞ cu yd are available, plus a number of interchangeable working tools such as brush stackers, dozer blade, and material handling forks.

CIRCLE (4) ON THE REPLY CARD

this certificate is proof

Southern Cross Foresters presents this Safety Certificate upon completion of each leakage survey.

It is visible proof that your company has employed recognized, impartial, outside specialists to locate leaks in its system.

In addition to the public relations value, the survey this certificate represents will prove a positive guide to the reduction of costly unaccounted-for.

Employing the latest Vegetation Methods and electronically instrumented Safety Surveys, SCF can take care of all leak location problems.

Our fully equipped system trained repair crews stand ready to repair the leaks located if you desire.

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SOUTHERN CROSS FORESTERS

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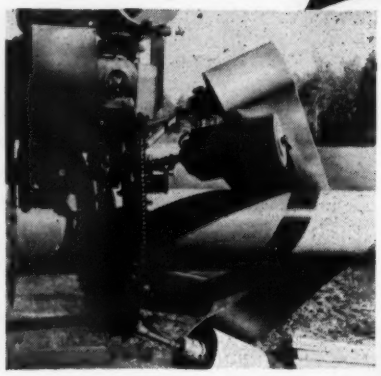
THE SEAMLESS RUBBER COMPANY



Seamless No. 657 Tape—High Density Blend Polyethylene Tape—Pipe line total Wrap.

Distributors also of:

CENTRAL PLASTICS: Flange Insulators and Insulated Unions.

H & M PIPE BEVELING MACHINE CO.: Beveling Machines, Dollies, Line Up Clamps, etc.

THERMOWELD: Thermite Connections for Anodes.

Protecto Wrap

Protecto Wrap PATCH PADS*—The economic and quality repair of skid damage to pipe line coating.

Prices and Literature are available on any of these or other products manufactured by these companies.

* U. S. PATENT No. 2-721,823

NEE & McNULTY, INC.

TULSA — HOUSTON — DENVER

BULLETIN BOARD

PRODUCTION OF BASIC OXYGEN STEEL at Kaiser Steel Corporation's Fontana, California, mill is described in a recently-published 16-page illustrated booklet. Oxygen steelmaking, the revolutionary new method of producing steel in minutes instead of hours, utilizes essentially the same basic raw materials as other methods of making steel — molten pig iron, scrap and fluxing materials—but the oxygen steelmaking method produces a "heat" of steel in approximately an hour, compared to 8 to 10 hours for open hearth steel. Booklet describes how the Fontana mill's oxygen steelmaking furnaces are constructed and how they operate. Also gives a brief history of the development of the new steelmaking process and its rapid adoption by the steel industry throughout the world. Kaiser's Fontana oxygen steelmaking plant is the largest of its kind in the world and the first in the West; it is rated at 1,440,000 ingot tons annually.

CIRCLE (5) ON THE REPLY CARD

HOW TO DETERMINE THE CORRECT WELDING ELECTRODE FOR THE JOB is the subject of a new 25-minute 16-mm full color film titled, *Arc Welding Electrode Selection*, recently produced for and now available by reservation from the Hobart Brothers Co. Basic factors important to correct electrode selection are discussed and a step-by-step procedure is outlined covering base metal identification, welding currents, welding positions, thickness and shape of base metal to be welded, joint design and fit-up, service conditions, production efficiency, environmental and job conditions — all fundamentally important in selecting the correct electrodes for the job at hand.

CIRCLE (6) ON THE REPLY CARD

COMPLETE SPECIFICATIONS on the new RPC-4000 electronic computing system are given in a catalog sheet available from Royal McBee. The RPC-4000 is a fully transistorized, electronic, stored program, general purpose computing system, for both engineering and business data processing. Basic system consists of the computer and a punched paper tape typewriter input-output unit. Optional high-speed input-output equipment is available.

CIRCLE (7) ON THE REPLY CARD

MASONRY AND CONCRETE SAWS AND BLADES are described in new product information folder and price list now available from the Truco Masonry Drilling Division, Wheel Trueing Tool Company. Folder describes company's masonry cutting equipment, including abrasive and diamond blades, heavy-duty masonry saws, concrete cutting saws, a standard masonry saw and a stone cutting saw.

CIRCLE (8) ON THE REPLY CARD

INDUSTRIAL VALVES AND LUBRICATING DEVICES are described in a newly-revised version of Lunkenheimer Company's comprehensive 500-page valve catalog, "Catalog 60." A special 24-page Valve Selector Guide section, which is illustrated and thumb-indexed, groups valves according to pressure classifications, enabling engineers to find specifications, reference data, and code requirements for any Lunkenheimer valve in a matter of seconds. Catalog also describes company's line of steel, iron, bronze, and PVC valves along with specifications and illustrations on lubricating devices, boiler mountings, cocks and other products.

CIRCLE (9) ON THE REPLY CARD

This photograph vividly demonstrates the excellent resistance of AMERICAN DUCTILE IRON® pipe to impact. After receiving the full force of a 3½-ton weight being dropped from a height of 25 feet, the pipe remains in one piece. The clearly defined puncture caused by the tip of the weight is an indication of the superior strength and impact resistant qualities of AMERICAN DUCTILE IRON ® pipe.

3½-TON WEIGHT DROPPED FROM 25 FEET FAILS TO SHATTER AMERICAN DUCTILE IRON® PIPE

Super-service requirements such as high internal gas pressures, heavy crushing loads and extreme shock loads can be met with extra-tough, bottle-tight AMERICAN DUCTILE IRON ® pipe. This pipe offers important advantages of both iron and steel, possessing the time-proven corrosion resistance of gray cast iron without the expense and inconvenience of special wrappings or special protective devices... and yet having high strength to withstand extreme installation and service stresses.

In crossing busy highways, under deep covers and fills, where shifting soil or earth settlement may be encountered... specify AMERICAN DUCTILE IRON ® pipe for gas service.

AMERICAN DUCTILE IRON ® pipe provides extra safety factors for all standard distribution pressures ... is easy to tap without saddles or welding... withstands shock in shipment, in installation, in service.

If you expect the extreme conditions, investigate AMERICAN DUCTILE IRON ® pipe. Your nearby American Cast Iron Pipe Company representative will furnish complete facts. Write for illustrated catalog.

GEM

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New York City • Dallas
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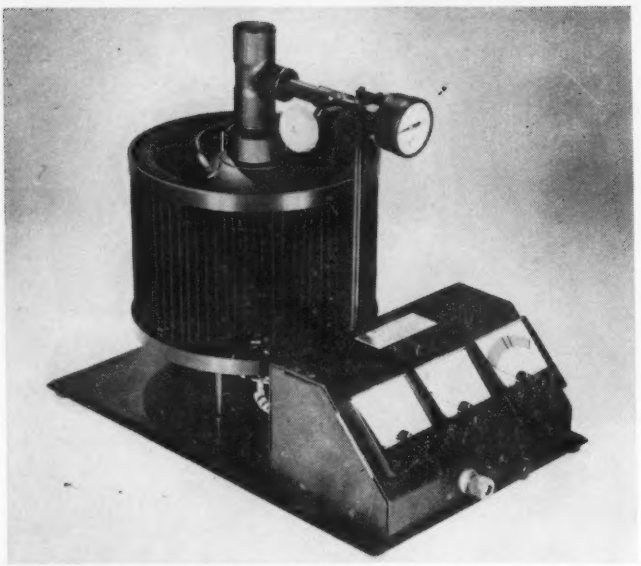

FIG. 1. **Photograph illustrates thermoelectric generator unit** that will be used on Northern Illinois Gas Company's experimental cathodic protection installation. Gage at top of unit is for input gas pressure to burner. Dials at bottom, left to right, are d-c volts, d-c amperes, and temperature in degrees F.

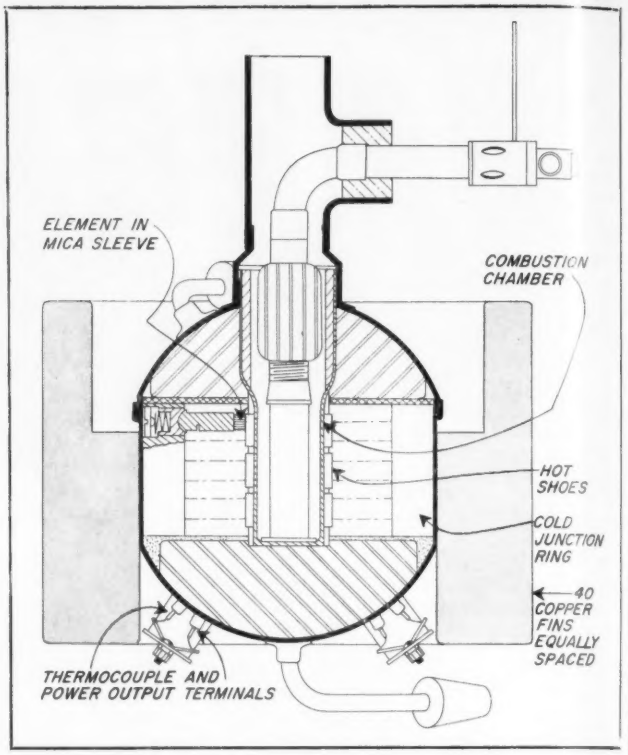

FIG. 2. **Cross-section** of the 10-watt, gas-fired thermoelectric generator unit, showing location of burner assembly, thermocouple elements, combustion chamber, cold ring, cooling fins, thermocouple terminals, and power output terminals.

Thermoelectric Cathodic Protection

Experiment at Northern Illinois Gas uses new concept — gas-fired thermoelectric generator to produce current for protecting gas mains

Earl Tornquist, *Director of Research*
Northern Illinois Gas Company, Bellwood, Illinois

AN "ALL-GAS" CATHODIC PROTECTION PACKAGE FOR GAS MAINS isn't as futuristic or fantastic as you might think. Devices that produce electricity directly from heat are among technology's newest products; natural gas is the finest source of heat energy, and electric power can be used to provide cathodic protection of gas mains. So why not combine these elements into one package?

That's exactly what the research and corrosion engineering departments at Northern Illinois Gas Company have done. Installation is underway of a gas-fired 10 watt thermoelectric generator unit that will provide current for cathodic protection of gas mains.

Cathodic protection procedures require a low voltage direct current. Use of a thermoelectric type generator, therefore, would have value in many cases as its output is d-c in the desired voltage range.

When applied to gas mains, the energy for its operation is always present. Present practice (not including those applications where sacrificial anodes such as magnesium or zinc can be used) requires bringing in an a-c power supply and installing rectifying equipment, including transformers to provide the proper voltage.

In those cases where electric power supply is difficult to obtain or very expensive to bring to the location needed, the use of the gas-fired thermoelectric generator would have considerable merit.

The energy cost, even at the present stage of development, is comparable to or less than the cost of purchased electric energy, excluding investment charges in both cases.

As the efficiencies of thermoelectric units increase, their advantages will be more pronounced and should show worthwhile economics in their favor over present systems.

Thermoelectric type generators with higher efficiencies — in the 100 and 200-watt sizes — are expected to be available in the relatively near future at prices that will be competitive in first cost with rectifier installations.

To obtain experience with this type equipment, Northern Illinois Gas decided to proceed with installation of the 10-watt unit on an experimental basis, using it to cathodically protect gas mains.

Design principles for such a unit had been established by Minnesota Mining and Manufacturing Company and they were willing to build one for this purpose.

While the unit will be placed in actual operation for cathodic protection of a section of gas main, the primary purpose of the installation is to develop operating experience and to determine design data for the future, not only for cathodic protection, but for many other applications where this type unit is considered practical.

How It Works

The generator to be used in the experimental cathodic protection installation is shown in Fig. 1 and 2. A schematic diagram of the field installation is shown in Fig. 3.

Operating Data
Gas-Fired Thermoelectric Generator
For Cathodic Protection Installation

Power Output	10.35 watts
Voltage to Load	3.4 volts, d-c
Hot Junction Temperature	1050 F
Cold Junction Temperature	214 F
Gas Pressure	3.9 psig
Gas Input Flow (Nat. Gas)	1.132 cu ft per hr
Chemical Energy Input	1147 Btu per hr
Overall Net Efficiency	3.08 percent

The generator incorporates 27 high efficiency thermocouples arranged in layers radially about a central core containing the gas burning heat source. These thermocouples directly convert some of the heat that passes through them into electrical power.

To insure efficient operation, the hot junctions (central core) must be kept at a relatively high temperature, while the cold junctions (outside finned case) must be kept cool as possible.

There is, however, a limit to the temperature at which the hot junctions can be run, so it is very important to observe this temperature (shown on the temperature indicating meter) while running the generator. These temperature limits, for the particular semiconductor metals used in this unit, are:

1. *Under no circumstances should unit operate at temperatures above 1100 F.*
2. *For long, continuous operation, unit should run with hot junction temperature at 900 to 1000 F or less.*

When the generator is in steady continuous operation, the hot junction temperature can still vary, depending upon the electrical load that is placed upon the output terminals. This temperature varies inversely with the electrical load. Certain precautions must be taken as follows:

1. When **removing** the electrical load from the generator, the fuel input must be **decreased** to maintain the same hot junction temperature.
2. When **connecting** an electrical load to the generator, the fuel input must be **increased** slightly to maintain the same hot junction temperature.

The generator can be run short-circuited with no damage.

Starting and Stopping Generator

Putting the unit into operation is a fairly simple procedure. The unit's gas input is connected to a regulated supply of 10 psig, and the needle valve on the burner assembly is opened until the pressure gage reads 8 psig.

The burner is then ignited by applying a flame or spark igniter to the top of the stack. The air shutter is adjusted until the flame travels down the stack and burns around the burner head. The air shutter is then opened to its maximum opening. After 1 or 2 minutes, the flame "pops" into the burner tube, which will then glow red hot.

When temperature reaches approximately 50 F less than the desired operating temperature, pressure is decreased by closing the needle valve until the desired temperature is attained.

As a guide, with a matched load (load voltage equal to one-half the open circuit voltage) the pressure for 1000 F operation is 3 psig and for 1100 F is 3.9 psig.

Stopping the generator is an equally simple procedure: Simply close off the gas valves.

Checking Operation

In the event an abnormally high pressure is needed to bring the unit up to temperature, the metering orifice may need cleaning or the sensing thermocouple attached to the temperature indicating meter may be faulty.

A cross-check on the temperature indication is the open circuit voltage of the generator (measured with a high-resistance voltmeter). Open circuit voltage is normally around 5 to 6 volts, and should never be allowed to exceed 7 volts. * * *

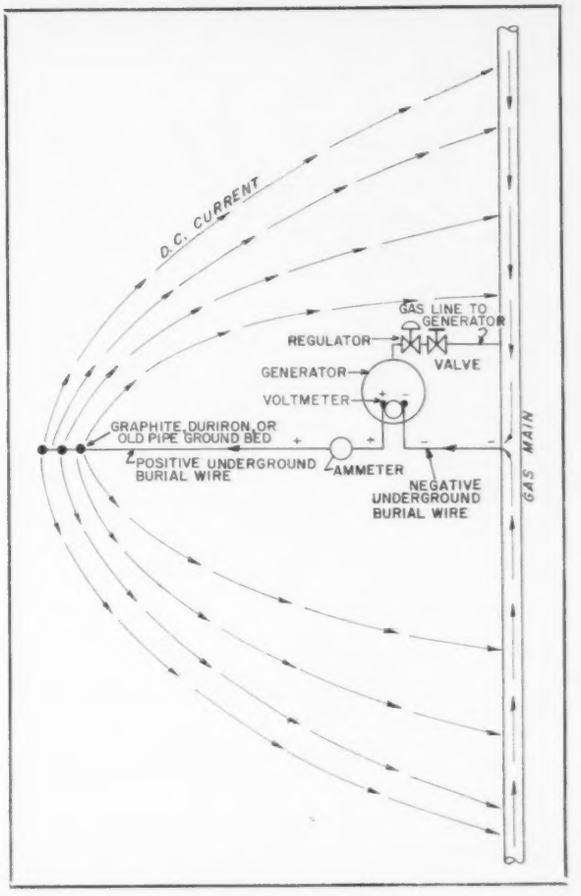

FIG. 3. **Schematic diagram** of the cathodic protection installation on a section of gas main.

Looking over test model of Minnesota Mining and Manufacturing Company's thermoelectric generator are, left to right, **Bob Cullen** of Northern Illinois Gas Company's Blue Island office; **Archie Steel,** 3-M sales manager; **Earl Tornquist,** NI-Gas director of research; **Ronald Koll,** 3-M products engineer, and **Dr. George Brown,** associate professor of chemical engineering, Northwestern University, and research consultant who works with Tornquist.

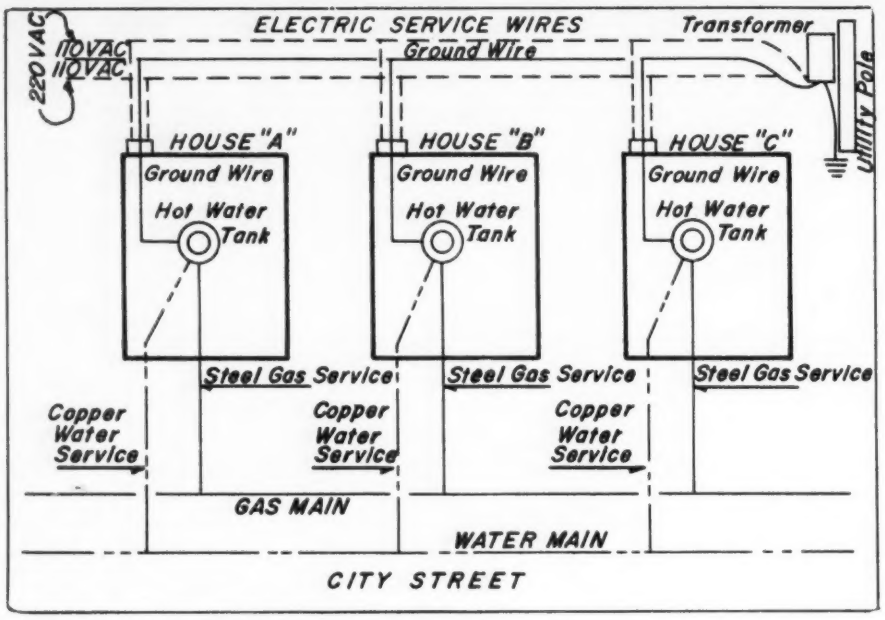

Fig. 1. Incidental electrical connections between gas, water, and electric services (uninsulated piping) are shown in the diagram.

Protection of Gas Service Lines In Non-Stray Current Areas

Peter P. Skule, *Chief Corrosion Engineer*
The East Ohio Gas Company, Cleveland, Ohio

PROTECTION OF GAS SERVICES AGAINST CORROSION probably has not had the detailed and close attention that gas mains have received.

When you consider that there are almost as many miles of service lines as there are distribution mains, the maintenance and protection of service lines can become a major problem if proper protection is not incorporated into the initial service design.

First, it affects the consumer personally and directly upon an early corrosion failure of a service, especially if it is a space heating consumer in the heating season.

Second, the services are usually the nearest gas lines to structures and, therefore, may be potentially more hazardous.

Third, there is the high cost of replacement to the consumer and the extra cost to the gas company in running down service leak complaints, turn-offs to repair or replace, and then turn-ons after the service has been repaired or replaced.

Fourth, the legal implications involved when injury or damage is sustained by a corrosion failure of a service line.

Usually, when a service line is found corroded, most companies replace or recommend the replacement of the entire service as repairs may eventually cost as much as a new service installation.

Complicating the protection design for services is the ownership of the service lines. Some companies own the entire service to the meter. There has also been a trend toward terminating the company's ownership at or near the property line. Legal, financial, and engineering complications dominate this latter view. Later trends have been to completely isolate the company's plant from the consumer's piping. Here, again, it is a legal and an engineering point that seems to have great merit. Irrespective of ownership, some general protection design features are possible with newly installed services.

Insulation of Services at or Near the Meter

Whether a service line is to be cathodically protected or not, certain general rules should prevail in the design of services. First and foremost important design feature is the electrical separation of the gas service from house piping and house wiring neutral grounds.

Fig. 1 indicates the typical interconnections that occur incidentally between water, gas, and electrical services in an uninsulated piping system.

It is an innocent looking electrical network but the corrosion of the gas service continues slowly, silently and uninterruptedly with an infinitely small galvanic current to pipe wall penetration until the detection of the escaping gas is made. Corrosion of mains is also greatly accelerated by connection to this network.

Common knowledge of galvanic current is that a copper water service acts as a cathode and that a mating steel gas

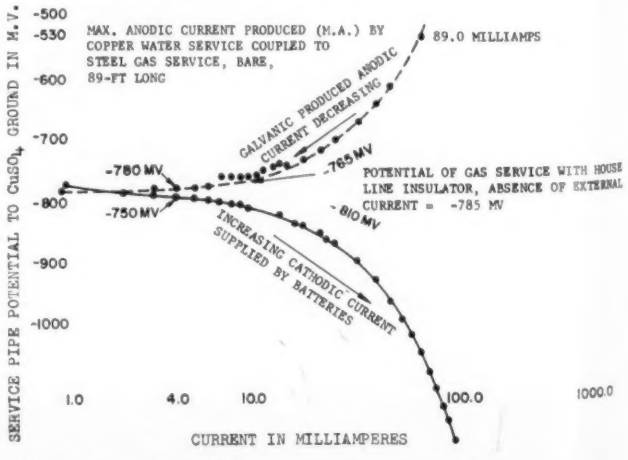

Fig. 2. Current-potential curve of a gas service line.

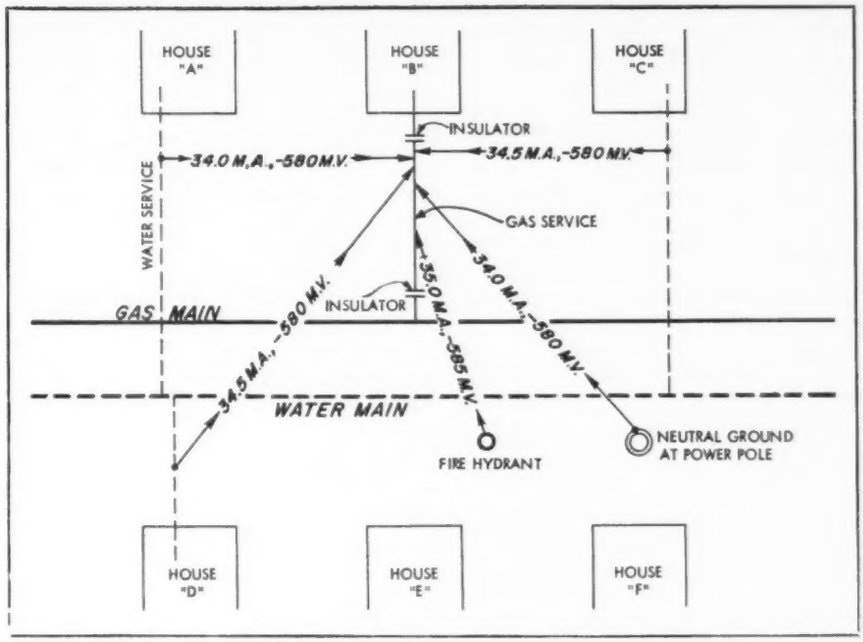

Fig. 4. Diagram shows how piping systems of homes are tied together metallically by electric grounds and water lines. Tests show that when isolated service at House B is connected individually by wire to each of the water piping systems of the various homes or to the electric power company neutral ground, precisely the same gas service potential-to-ground resulted, and exactly the same amount of corrosive current was introduced into the gas service of House B. In all of the tests shown, the gas service to House B was completely insulated at its extremities and an anode was attached to the line.

service acts as an anode when coupled to the copper water service. *This is perhaps one of the most destructive elements in the corrosion of uninsulated steel gas services.*

Other common galvanic combinations more difficult to appraise are new services tied to old mains, new mains tied to old services, steel services tied to cast iron gas mains, steel gas mains tied to cast iron water mains, steel gas mains tied to copper water services, and cast iron water mains tied to copper water services.

The above general principles are all well understood but they are sometimes slighted because of the infinitely small currents involved. Therefore, we will attempt to emphasize the principles by presenting some theory and also some detailed results obtained during a series of experimental tests carried on for several years on service insulation and protection.

It appears that when steel gas services, copper water services, and house wiring grounds are all electrically tied together (Fig. 1) a general metal network potential to ground results that is usually more positive by 0.1 to 0.2 volts than the potential of an isolated non-protected steel gas service in the same general area.

In other words, the resulting network potential is not directly related to any one home (Fig. 4) but it is the overall effect of the soil type, moisture in the soil, lengths and size of copper or steel water services, length and size of steel or copper gas services, and the resistance of the electrical neutral ground circuits within the homes and between the homes via the grounded neutral. With all copper plumbing in the home resistance is usually very low. Meter bars likewise tend to decrease the resistance between the gas service and the house piping.

The neutral ground wire on the poles between the homes ties and equalizes the potential to ground of all the various metals in the network. Then each of the metals in the network usually has a very similar structure to ground potential in the area of the ties.

In fact, the potential of the grounded neutral on a pole from a transformer will generally reflect the general network potential within the area served by that transformer.

While in some areas several transformers are not tied together by their secondary leads, the water and gas mains can, and sometimes do, thereby extending the general network involved beyond the area served by any one transformer.

Generally, cast iron water mains are not of low resistance but steel gas mains usually are of low resistance and they may create this tie between transformers.

In Fig. 3 is shown the galvanic current produced by each pair of services, one copper water service and one steel gas service, to new homes completely isolated from the electric grounding system within the homes and between the homes.

The resulting anodic galvanic current produced by 60 ft of ¾-in. copper tubing and 60 ft of bare 1½-in. steel pipe varied between 15 and 79 milliamperes at driving voltages ranging from 0.145 to 0.380 volts. These services were laid in a heavy wet clay soil area ranging from 2000 to 4000 ohms resistance per cubic centimeter.

Usually, the anodic current is somewhat less in older homes where polarization has had time to act upon the copper water service. But complete copper water line polarization has not been detected. This is probably due to ties to water mains.

In another instance, 8.5 milliamps of current was detected. In six years a steel gas service failed by corrosion.

The inapparent seriousness of 8.5 milliamps of anodic current is brought to light by the fact that an anodic current of 8.5 milliamps flowing for six years did remove a pound of steel in the gas service line.

Considering that 1½-in. steel pipe weighs only 2.7 lb per ft and if all of the 8.5 milliamps of current were con-

FIG. 3. Galvanic Current Produced by 60-ft Steel Gas and 60-ft Copper Water Service Lines Coupled Together Causing Steel Gas Services to Become Anodic in Homes.

House	Milliamps Produced	Millivolts Between Steel and Copper
A	20	200
B	30	300
C	16	150
D	43	350
E	15	145
F	79	380
G	32	350
H	28	380
I	22	280
J	16	260
K	26	275
L	29	330
M	61	240

Note: Neither gas or water services are in contact with the grounded neutral in the above houses.

centrated at one location then a length of 4.6-in. of bare 1½-in. steel service pipe would be completely destroyed in six years. Usually several penetrations result when the anodic current is not localized.

Service Pipe Potentials Affected by Galvanic Action

Where a gas service line is insulated at the main but not in or near the structure served and that structure or others nearby have copper water services then the service line potential will usually be more positive than an isolated non-protected steel service in the same area. Where services are metallically tied to unprotected mains the service potential change will be considerably less.

These potentials have been observed to be as low as −300 millivolts to a copper sulfate electrode whereas the normal potential should have been close to −600-mv.

Fig. 2 clearly illustrates the devastating effect caused by 89 ft of ¾-in. copper water line that was coupled to a similar length of 1½-in. bare steel gas service in a wet clay soil. This gas service was insulated at the main.

With this condition, 89.0 milliamps of anodic current held the gas service line potential down to −530-mv. to a copper sulfate electrode which apparently was not extraordinarily low as pipe potentials go. When the gas service line was insulated at the meter the gas service line potential immediately dropped to −785-mv., an improvement of 0.255-volts by this one simple act.

Note in Fig. 2 that, as the anodic current was gradually decreased with a variable resistance, the gas service line potential improved in a negative direction. Then, applying cathodic protection, the service line potential properly attained full protection.

Interesting to note is that in extremely close pipe potential cases the service line potential can be misleading in so far as actual service line corrosion is concerned. For example (Fig. 2) with 4.0 milliamps of anodic current acting on the service the service line potential is pegged at −780-mv. and with 4.0-ma. of cathodic current supplied the service line potential was only −790-mv. Though the line potentials are relatively close together there is a great difference as to whether the service line is under anodic or cathodic influence.

In such close cases parting the gas meter connections and measuring the actual current flow and direction of flow is a more reliable indication of the true condition. Sometimes in place of parting the meter connection gradients may be taken on the house line but in view of the infinitesimal currents involved detection is difficult.

In many cases, however, the service line potentials will show a wider range so that with experience one can judge whether anodic or cathodic control is in effect.

Insulating Services at the Main

Practices vary so between companies that only general principles can be discussed.

Where the distribution mains are coated and are cathodically protected and the service lines are bare, then insulation at the main is most imperative to separate these bare services, which in a closely built-up area may add considerable bare steel surface to the coated mains.

Where the mains are coated and protected and consumer or company owned services are coated and insulated at the meter, then insulation at the main is not technically essential and some firms actually bond at this point and protect the services and mains together.

While, from a corrosion engineer's view point this is ideal, as you have an integrated protection system. Yet there is a growing tendency to remove all metallic contacts between the consumers property and the gas company's facilities. Perhaps this is good legal foresight.

The moot question of assuming the continuous responsibility to provide cathodic protection to a consumer owned service is not clear and concise. In view of this we presume that the trend is to insulate at the main or at the juncture of lines under different ownership. However this method has one advantage for the corrosion engineer.

Where mains are coated and protected, insulators at each end of a serivce will practically insure main line electrical separation from house piping for if one fails the chance is that the other will remain effective. Should a few insulators at the main become ineffective only it simply means that several 40 or 50-ft bare or coated service lines are attached to the main that will not completely bog down the protection system on the main.

Cathodic Protection of Bare Services

Where individual existing services are bare or coated or where there is to be no cathodic protection on the main, it appears that, in ordinary soils, a bare service line can be economically protected by anodes.

But, first, insulation at the main and at the meter is required.

In Fig. 5 are shown 20 adjacent homes having an average

FIG. 5. Bare 1½-in. Service Pipe Potentials (Average 50-ft Length) Protected by Various Sizes of Magnesium and Zinc Anodes

House	Soil Resist. Shepard Canes	Anodes Inst. 1952	Weight of Anode Metal	Potentials (millivolts) 1953	Potentials (millivolts) 1956	Potentials (millivolts) 1959
A	4000 Clay	3-D Mag. Bare	3 lb	— 800	— 850	— 740
B	2800 Clay	5-D Mag. Bare	5 lb	— 820	— 800	— 700
C	4000 Clay	4-D Mag. Bare	4 lb	— 910	— 850	— 830
D	3600 Clay	5-D Mag. Bare	5 lb	— 875	— 950	— 805
E	2800 Clay	1⅜″ x 17″ Zinc	6.3 lb	— 880	— 850	— 800
F	2500 Clay	1⅜″ x 12″ Zinc	4.5 lb	— 780	— 900	— 805
G	2300 Clay	3-D Mag. Bagged	3 lb	— 950	—1000	— 905
H	3000 Clay	5-D Mag. Bagged	5 lb	—1080	—1000	— 850
I	2500 Clay	3-D Mag. Bagged	3 lb	—1110	—1000	— 820
J	3200 Clay	4-D Mag. Bagged	4 lb	— 945	—1000	—1010
K	3000 Clay	4-D Mag. Bagged	4 lb	—1020	—1000	— 850
L	4000 Clay	4 D Mag. Bagged	4 lb	— 950	—1020	—1000
M	3000 Clay	5-D Mag. Bagged	5 lb	—1005	—1000	— 980
N	3400 Clay	1⅝″ x 24″ Mag. Bare	1.76 lb	—1020	—1000	— 900
O	3000 Clay	1⅜″ x 12″ Zinc Bare	4.5 lb	— 840	— 900	— 900
P	4000 Clay	1⅝″ x 17″ Mag. Bare	1.25 lb	— 980	— 950	— 930
Q	3000 Clay	1⅝″ x 18″ Mag. Bare	1.32 lb	— 990	— 950	— 920
R	3600 Clay	1⅝″ x 18″ Mag. Bare	1.32 lb	— 950	— 820	— 965
S	5000 Clay	1⅝″ x 18″ Mag. Bare	1.32 lb	— 880	—1000	— 925
T	3000 Clay	1⅝″ x 24″ Mag. Bare	1.76 lb	— 950	—1000	— 940

3-D Bare Anode = Dow 3 lbs bare anode 4″ x 4″ D-shaped cross section 4.75″ long.
4-D Bare Anode = Dow 4 lbs bare anode 4″ x 4″ D-shaped cross section 6.25″ long.
5-D Bare Anode = Dow 5 lbs bare anode 4″ x 4″ D-shaped cross section 7.50″ long.
Bagged 3-D, 4-D, 5-D anodes same dimensions are bare with back-fill added. All others shown with dimensions are round and are bare.

FIG. 6. Experimental Cathodic Protection of Existing Gas Services By Anodes and Insulation of Service Lines.

House	Bare or Coated Service	Galvanic Current Produced by Copper-Steel Couple In Milliamps	Service Pipe Potential To $CuSO_4$ Grd Before Anodes		Material and Weight of Sacrificial Anodes		Anode Protected Service Line Potential To $CuSO_4$ Grd With Cu Water Line In Millivolts	Anode Protected Service Pipe Potential To $CuSO_4$ Grd Service Line Insulated at Both Ends In Millivolts
			Before Meter Insulated Millivolts	After Meter Insulated Millivolts	Zinc or Mag	Lb		
A	Coated	65.0	—320	—600	Mag	7.1	—635	—1062
B	Coated	6.0	—350	—755	Mag	1.6	—430	—1040
C	Bare	35.0	—420	—790	Mag	3.0	—668	— 980
D	Bare	88.2	—540	—795	Mag	2.6	—560	— 840
E	Coated	2.9	—420	—670	Zinc	18.4	—560	—1030
F	Coated	2.5	—600	—750	Mag	2.5	—560	—1600
G	Coated	1.6	—575	—635	Mag	1.6	—560	—1185
H	Coated	0.13	—590	—665	Zinc	6.7	—560	— 880

50-ft length of 1½-in. bare gas service line insulated at their extremities which were experimentally cathodically protected at random with various sizes and shapes of magnesium and zinc anodes in clay soils ranging from 2300 to 5000 ohms resistance. Also shown are potentials obtained eight months after the installation of anodes and again three years and six years after anode installation. Some of these anodes are at the ends of the service, some are centered with service, but most of them are at the service tap tie-in.

It is obvious that fairly good results can be obtained in protecting bare services but the current requirements for the above are in the order of 10.0 milliamps or more and the protective potential develops very slowly after installation. The anode life is reduced because of the large current drawn for so small an anode.

With the limited protection system involved, polarization takes place eventually so well that the service line potentials often drop after several years of operation. Chemical backfill around an anode appears to maintain potentials better than in cases of anodes without backfill.

Zinc did fairly well in comparison to other type anodes despite the relatively high resistance soils involved.

Cathodic Protection of Coated Services

Individually coated service lines averaging 50-ft in length will respond exceedingly well with cathodic protection by anodes if the extremities of the services are insulated.

About 1.0 to 2.0 milliamps is required for coated services and they attain immediate protection right after installation. Three-pound zinc anodes produced excellent results in these cases.

Existing Service Lines

At times a limited area shows a definite trend toward early service line corrosion. When this occurs it may be prudent to establish the cause and make recommendations to improve the remaining services. Though this is a gigantic undertaking it is sometimes done as a last resort.

If proper insulation was provided for in the initial installation the job is much less complicated. But if the proper insulation of the service was not incorporated, the reconstruction is expensive.

In the suspected area, service line potentials are recorded and if they are well below normal (more positive than normal), there is no doubt that external forces are causing the positive condition (Fig. 6). A few checks at parted meter connections will indicate the current value, direction and the driving voltage.

A pressure check is then made and if the service line holds, insulation may be provided at both ends of the service with an anode to protect the service from further corrosion. Where the main is under protection then only insulation at the meter need be provided.

Construction Notes for Services

1. Always lay a full joint of pipe beginning at the house.
2. Do not lay steel gas service lines in the same trench with copper water lines.
3. On bare pipe, tape the risers at ground level and tape wall pieces.
4. It is best to coat the pipe, isolate the service, and protect with an anode.
5. Individual cathodically protected services crossing rectifier protected bare structures will lose protection at the crossing — only excellent coating will protect the service.
6. Services near steam lines are usually subject to greater corrosion.
7. Insulate services from cast iron mains.
8. Do not lay bare services where much de-icing salt is used.

Testing of Insulating Joints

The mere installation of an insulating joint is not always a guarantee that insulation is effective. It is necessary to test insulating flanges and couplings as they are installed. Even insulating unions are not always foolproof.

Perhaps the most widely used accessory is the bulb type continuity tester. These generally serve well in most instances but in some cases the testing current short circuiting through ground around an insulator presents a problem. In these cases other more detailed methods may have to be employed such as volt meters and pipe potential checks on either side of the joint.

Conclusions

1. It is most essential that an insulator be installed at or near the meter end of the service line to disassociate the steel gas service from neutral grounds, house piping, and water service lines irrespective of whether the service line is to be or not to be cathodically protected. This will also prevent corrosion to the mains if there is no insulation at the tap.
2. It is essential that an insulator be installed at the juncture of the service line with the companies' property where the service is to be cathodically protected individually or where the main is to be protected and not the services.
3. Insulators should be checked for effective installation.
4. Individual bare steel and coated steel services are easily protected with anodes if the service line is insulated at its extremities.

Acknowledgment

This article developed from a presentation made at the Fourth Annual Appalachian Underground Corrosion Short Course, University of West Virginia, Morgantown, West Virginia.

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AMERICAN GAS FUNDAMENTALS

Corrosion Notebook

Plastic Pressure-Sensitive Tapes As Pipe Coating Materials

HOW GOOD ARE PLASTIC PRESSURE-SENSITIVE TAPES FOR USE AS PIPE COATING MATERIALS? How do they compare with other pipe coating materials with regard to physical, electrical, and chemical properties?

While experience data on the performance of plastic pipe wrapping tapes is limited to approximately 10 years, a number of firms employing these materials in that time have reported favorably on the behavior of plastic tapes.

From this experience data, and from both laboratory and field investigations, have come certain conclusions about plastic pressure-sensitive tapes:

1. Plastics, such as polyethylene and polyvinyl chloride (PVC), have electrical, physical, and chemical qualities for pipe coating that compare favorably with competitive materials.

2. In some cases, applied costs of plastic tape pipe coatings are competitive with, or less than, equivalent conventional materials if all factors are considered. The upward trend of both labor and material costs is in a direction favoring plastic tapes.

3. Application of tape coatings, compared with hot applied materials, is simpler; requires less skill, less manpower, and less equipment, and is a safer operation.

4. Plastic tapes are being used under a wide range of terrain and weather conditions on a variety of piping systems, ranging from gas service lines to major large-diameter gas transmission pipelines.

5. Utilization of pressure-sensitive adhesives has made it possible for plastic tapes to be developed into acceptable pipe coatings. With a number of adhesive formulations available, tape manufacturers must select only those that will remain stable over a long period of time when subjected to the various conditions to which pipe is exposed.

All pipe coating materials have their limitations, and plastic tapes are no exception. The upper temperature limit for continuous operation of plastic tapes is generally considered to be in the range of 150 to 200 F, which does not differ substantially from competitive pipe coating materials. Plastic tapes will generally withstand temperatures well below 0 F but they become stiff and application is not advisable at low temperatures unless humidity is low and tape tension is increased to allow for expansion of the tape when line temperature increases.

Unshielded plastic tapes, like most other unshielded coatings, are not outstanding in their ability to withstand damage caused by dragging pipe over rough terrain; other insulating coating materials may be used but may not resist dragging depending on the temperature and physical resistance of the material employed.

Future developments in adhesives when coupled with newly discovered plastic materials may allow plastic pressure-sensitive tapes to be employed at higher temperatures and under more severe chemical and physical conditions than are at present possible with conventional pipe coatings.

Purpose of this report is to provide a realistic, documented appraisal of plastic pressure-sensitive tapes as pipe coating materials. Included are discussions of factors that are important in a pipe coating, comparative data on various coating materials, and experiences of various organizations with plastics as pipe coatings. Also included are data covering the results of both field and laboratory tests on various types of pipe coatings.

Function of a Pipe Coating

External coatings are applied to pipe that is to be installed underground or underwater to prevent corrosion damage to the pipe. The term "corrosion," as applied to metals, is usually defined as the destruction of a metal by electrochemical reaction with its environment.

It is generally agreed that underground and underwater corrosion is caused by the flow of electric current from a metallic structure into the surrounding soil or water. The points at which current flows from the pipe into soil or water are called anodes. Accelerated corrosion takes place in anodic areas. Current pickup areas are called cathodes. Normally no corrosion occurs in cathodic areas. These electrical currents result in corrosion that is determined by electrical rather than chemical factors. Almost every person who has had experience in maintaining underground piping has observed corrosion of piping developing leaks under paved roads with piping on either side in good condition. This is a common example of an oxygen concentration cell (sometimes called a differential aeration cell). Effect of such cells is to promote corrosion where the oxygen content in the soil or in the water is least.

Also familiar is the corrosion of steel pipe adjacent to brass or bronze fittings. This type of corrosion is called *galvanic* and results from the difference in electrical potentials of the ferrous and nonferrous metals with respect to the surrounding soil or water. Galvanic corrosion can result from combinations of two different metals in the same soil or two different soils contacting the same metal. Galvanic currents may be measured easily in a laboratory, and with somewhat more difficulty in the field.

One of the most severe types of galvanic corrosion is that caused by the use of cinders as a backfill material. Cinders behave like a highly cathodic metal such as platinum and, when cinders contact most structural metals, rapid deep pitting usually occurs if soil is moist or wet.

Similar corrosion effects may also be caused by stray electric currents originating in multi-grounded direct current distribution systems.

In all of the commonly found corrosion mechanisms described above, the direct cause of corrosion is the flow of current from a metal into an electrolyte.

Six principal methods of preventing underground or underwater corrosion are:

1. **Use a metal that does not corrode in the environment under consideration.** This is often not practical for economic reasons. For example, titanium would be an excellent material for pipelines submerged in sea water. Titanium, however, costs about $13 per lb compared to about 10 cents per lb for steel.

2. **Treat the environment so as to make it noncorrosive.** This is often practical in closed liquid systems such as automobile radiators where the addition of 1 or 2 percent of a cheap corrosion inhibiting chemical will do the job adequately. Obviously, it is not economic in the case of underground piping where the environment is uncontained and is almost limitless in extent.

3. **Provide a cladding of a metal** that does not corrode in the environment. This can be accomplished economically on tanks, heat exchanger tubes, wires and cables, etc., but is usually too expensive on structures such as underground pipes. Clad materials also present special jointing problems.

4. **Avoid the corrosive environment altogether.** This would mean rerouting the pipe so as to avoid areas known to be corrosive. This is rarely a practical scheme since the choice of right of way is often dictated by other requirements.

5. **Provide cathodic protection by means of galvanic anodes or rectifier installations.** The cost of cathodic protection on a bare pipe is many times that on a coated pipe and complications often arise because of unwanted interference with other buried structures. This becomes a more important factor as congestion increases. In an urban area it generally would not be considered good practice to apply cathodic protection to a single isolated bare pipe without considering the effects on other buried structures.

6. **Apply a long lasting insulating coating** to prevent the flow of corrosion currents. This method is by far the most popular method of corrosion control and has been practiced for over 100 years. Within the last decade or so it has become common practice to combine the use of insulating coatings with cathodic protection and thereby realize the advantages of both methods.

Use of Insulating Barrier Films

The use of insulating barrier films as a corrosion preventive on underground piping dates about 100 years. At that time most piping was cast iron or wrought iron for conveying water at pressures generally less than 50 psi or gas at pressures of less than 1 psi.

For many years, bituminous materials such as coal tars and asphalts were the basis of most coatings. These were hand applied either with or without reinforcements of burlap or felt. Performance of early pipe coatings was as uneven as the coatings themselves. In some cases the reinforcing materials rotted away, leaving a porous bituminous material behind, which offered little protection to the pipe. In other cases, cold flow of the pipe coating materials under the influence of soil stresses tended to crack or remove the coating. It was soon realized that better methods and better materials would be required to be developed if predictable and satisfactory performance was to be obtained.

In time these better materials and more appropriate application methods were developed so that now it is possible for an engineer to specify a coal-tar or asphalt coating for almost any underground pipe installation and feel confident that the coating will perform adequately (provided that installation is well supervised and cathodic protection potentials are within proper limits).

If the presently employed bituminous coatings are serving the purpose why, then, are some companies switching over to plastic pressure-sensitive tapes? It is believed that the answer to that question is largely one of economics, although other factors appear to be involved. It must be remembered that bituminous materials have been used for many years without being faced by competitive materials (with the exception of certain waxes).

The phenomenal growth of the plastics industry since World War II and the consequent decrease in the price of plastics has produced many changes in the wire and cable industry with plastic insulation replacing rubber, paper or varnished cambric in many cases. In the pipe and conduit industry, tubular plastics have come into widespread use, particularly in the smaller sizes, and for low-temperature and low-pressure service. Gradually, larger and larger sizes of plastic pipe are becoming available and there is more choice as to temperature and pressure ratings.

Cathodic Protection as a Supplement To Coatings

An insulating coating, if relied upon as a sole means of preventing corrosion, must be completely free of pinholes, breaks or other discontinuities in order to be 100 percent effective. In actual practice, this degree of perfection is rarely, if ever, achieved and as a result there are small areas here and there that are left completely without protection. It has been observed by a number of engineers that an imperfectly coated pipe will often develop corrosion leaks more rapidly than a bare pipe in the same environment, assuming that neither pipe is under cathodic protection.

It is not unusual these days to have steel pipelines 30-in. and larger in diameter, 1500 miles or more in length, transmitting natural gas or oil at pressures of 500 to 1000 psi so economically that no other method of transmitting such large blocks of energy is competitive. In order to achieve this economy it is necessary to eliminate corrosion allowances in the steel pipe and to stress the steel as highly as is consistent with safe operation. Corrosion cannot be tolerated on these major pipelines because of possible damage to life and property, hazards of fire or explosion, loss of product, interruption to service and high cost of repairs.

The economical solution to the problem is to employ cathodic protection to prevent corrosion at coating faults. If there are no complicating factors, the initial cost of applying the small cathodic protection current can be as low as $100 per mile of pipe for a system that may last 20 years or more.

If cathodic protection is an effective method of preventing corrosion why bother with the coating at all? Why not rely totally on cathodic protection instead?

This method has, in fact, been used successfully in a number of cases to provide partial protection in rural areas where piping was originally installed without coatings. In congested areas, this method runs into difficulty because of undesirable stray current effects on other nearby buried piping and cable sheaths and, therefore, it is not good practice to protect an isolated bare pipe that crosses or parallels other piping unless special precautions are taken to avoid damage to the crossed line. The cost of additional engineering involved on a job such as this can be very great. **Complete** cathodic protection of a bare pipe is possible but is usually considered to be prohibitively expensive.

Modern practice on important piping is to provide a good coating plus cathodic protection sufficient to take care of the minor defects which usually develop in the course of lowering and backfilling operations. The combination of a high-quality coating and cathodic protection is both economical and safe.

Before the advent of good coatings and cathodic protection it was necessary to go to excessively heavy walled pipe in order to allow for corrosion. Assuming a corrosion allowance of ⅛-in. wall thickness, the extra weight of steel required per square foot of pipe is calculated to be 5.1 lb. It is estimated that the additional cost of the extra steel would be about 75 cents per sq ft of pipe. In the case of a 1500 mile, 30-in. diameter line, this would amount to $45,000,000 — which is a lot to pay for such an uncertain means of postponing corrosion failures.

Properties of an Ideal Pipe Coating

The purpose of a coating on buried piping is to provide an electrically insulating barrier between line pipe and its surroundings. This may sound like a very simple procedure but in actual fact a coating is not worthwhile unless it retains its insulating properties over long periods of time. To accomplish this, an ideal coating must resist all manner of environments likely to be encountered underground, as well as aboveground, during and after installation.

Electrical Resistance. A pipe coating should have a high electrical resistance per square foot of coated area and the value of this resistance should not decrease markedly with time. The resistance of a flawless pipe coating measured directly after backfilling with dry soil reflects the volume resistivity of the material. After a few months, under average rainfall conditions, the measured value will usually decrease. The amount of decrease in resistance is dependent upon the amount of moisture absorption and the resistivity of the moisture being absorbed.

For instance, a pipe immersed in a low-resistivity salt marsh would be expected to have a much lower effective coating resistance than a duplicate pipe buried in high-resistivity sand.

The resistance of a coating is dependent upon the volume resistivity of the material and the thickness of the material. Thus it is not necessary to have a great thickness of coating if the material has a high inherent volume resistivity (other factors being equal).

Because of the wicking action of reinforcement materials and because of minute cracks or pinholes that can develop where rocks press into the coating, the coating resistance as measured in the field rarely approaches the high values that would be expected from calculations based on the volume resistivity data supplied by the manufacturer. This is normal and should give no cause for concern.

In average soil, a coating resistance of 1 million ohms for 1 sq ft of pipe surface would normally be considered satisfactory. Stability is a very important characteristic of a good pipe coating, and for this reason comparisons of pipe coatings should not be made from only a single set of data. It is better to make several sets of tests over a period of several years and to select the coating that would be predicted to have the highest resistance for 1 sq ft after a period of 10 years or more. It is not initial performance that counts but performance over a long period of time.

Resistance to Actions of Acids, Alkalis, Hydrocarbons, Soil Organisms, Sunlight, Etc. The chemical environment in most soils is usually not too severe but it must be remembered that a coating must resist deterioration over several decades.

Except in the immediate vicinity of certain industrial operations, the pH of most soils is in the range of from 4 to 9. After prolonged application of cathodic protection, however, the pH at pinholes and other coating defects may be as high as 13. For this reason it is absolutely essential that any pipe coating designed for underground or underwater use be highly resistant to alkali.

Hydrocarbons, such as crude oil or gasoline, are frequent soil contaminants in oil fields, refineries, and airports. Coatings used in such locations should be resistant to hydrocarbons although some dimensional changes could be tolerated.

Organisms, such as bacteria and fungi, are commonly found in soils and a coating that serves as a food for these forms of life may prove unacceptable.

Sunlight deteriorates many pipe coating materials. This need not be of concern where the coating application is made over the trench just prior to lowering in. It is also possible to provide a shield (such as a felt) over the coating and thereby prevent direct exposure to sunlight.

It is the practice of some companies to purchase mill-coated pipe and store it outdoors for future use. Usually, the storage period is only a few months but some of the pipe, particularly if it is of an odd size, is permitted to remain in storage for several years before it is installed underground. In addition there are some locations such as on bridges where a pipe coating may be exposed to sunlight for many years.

Plastic pressure-sensitive tape coatings for underground use are nearly always applied just prior to backfilling. Inasmuch as the tape itself is customarily stored indoors, resistance to sunlight damage (ultra-violet light) would not be of primary importance for tapes except where service is aboveground.

Ability to Resist Mechanical Damage Before, During and After Installation. Steel is one of the toughest construction materials known to man. The insulating coatings that are applied to steel pipe are, of necessity, not as tough as the pipe and therefore can be considered at least somewhat vulnerable to mechanical damage. If the extent of the damage can be limited to a small fraction of 1 percent of the coating area, then cathodic protection can be applied economically because of the small currents required.

Damage to coatings before installation can often be visually spotted and repaired. Damage during installation can be located after backfilling by electrical means such as with electronic fault detector of the Pearson type. Mechanical damage after installation can be caused by the prolonged action of cyclic soil stresses. These soil stresses result from expansion and shrinkage of soil as it wets and dries.

A coating system must be able to resist puncture by small stones; where larger rocks do puncture the coating there must be no tendency for the coating fault to grow larger with time.

Repairs to Coatings. A certain amount of damage to pipe coating is almost unavoidable. The damage may be carelessness, vandalism, or the result of an accident. In cases where there is a considerable amount of damage it may become advisable to repair the damaged areas. For this reason a coating which is quickly and easily repaired with a material that duplicates or is compatible with the original coating material is to be preferred (other factors being equal).

Cost Must Be Reasonably Low. As mentioned previously, there are several methods of controlling corrosion. Insulating coatings plus cathodic protection are usually economical for large lines. In some cases, on small pipe operating at low pressures at normal soil temperature, it may be cheaper to use plastic pipe or galvanized pipe.

Material Should Be Easily Applied Under Widely Varying Weather Conditions. The quality of many pipe coating systems is dependent to a large extent upon the skill of the applicator, weather conditions, and the rigorousness of the inspection. The less dependency there is on these factors the less chance there is for the coating system to fail to perform as it should.

Ideally, a pipe coating should be capable of application under any field conditions under which construction is undertaken. This would include ambient temperatures from about 0 F to above 100 F, and humidities of from 0 to 100 percent.

Physical, Electrical and Chemical Properties Of Various Pipe Coating Materials

In selecting a pipe coating system, it is important to know the limitations of the materials being considered. Below are listed some representative data obtained from technical literature that compares the pertinent properties of a number of pipe coating materials.

Volume Resistivity. Because the purpose of a pipe coating is to serve as an electrically insulating barrier, volume resistivity is the most important characteristic of a coating material. In a comparison of differing materials, the customary coating thickness must also be taken into account. Volume resistivity is usually given in terms of the resistance between opposite faces of a cube whose dimension is 1 centimeter (usually called ohm-centimeters).

Unfortunately the standard industry method of measuring volume resistivity (ASTM D-257) is not entirely applicable to coatings for use underground since the tests are made before immersion in water. Materials such as Teflon, having little or no water absorption, will undoubtedly be almost unaffected by exposure to moisture while other insulating materials, such as some of the early unimproved asphalts, would be expected to be electrically degraded by prolonged exposure to moisture.

The following laboratory values of volume resistivity were obtained from technical literature and are believed to be representative.

Material	Volume Resistivity (ohm-cm)
Asphalts, modern type	10^{16}
Coal-tar enamels	10^{12} to 10^{15}
Epoxy resins	10^{14}
Microcrystalline waxes	10^{15}
Polyethylene	10^{16}
Polyvinyl chloride	10^{13} to 10^{15}
Vinylidene chloride	10^{14} to 10^{16}
Cellulose acetate	10^{13} to 10^{15}
Polypropylene	10^{16}

All of the above materials are being used in pipe coating systems, and can be considered as good insulation when in a dry state. In actual practice on operating lines, much lower values are normally encountered because of the effects of moisture absorption, wicking action of reinforcement materials (if used) and coating damage.

Fig. 1 shows how coating resistance varies with coating thickness for a range in volume resistivity of the coating material. It can be easily seen that a thin coating must have a higher volume resistivity than a thick one in order to have the same resistance for one square foot.

Moisture Absorption and Transmission. In order to maintain a high coating resistance over long periods of time, it is essential that the insulating material not be adversely affected by exposure to moisture. Probably the most commonly used criterion is moisture absorption expressed as a percentage of the original dry weight of the test specimen.

For plastics, *ASTM Test Method D-570* for 24-hour immersion is most commonly used. It should be pointed out that specific gravities of materials should be kept in mind when making comparisons of moisture absorption. For instance a plastic having a specific gravity of 2.0 and moisture absorption of 0.6% actually absorbs **more** water than a plastic having a specific gravity of 1.0 and moisture absorption of 1.0%.

Some coating authorities maintain that moisture transmission — rather than water absorption — should be employed as a criterion. There would be no objection to this provided that it could be shown that long-term electrical insulating qualities are more closely related to moisture transmission than to moisture absorption. It generally is accepted that neither moisture absorption nor transmission is a desirable property for an insulating material.

The following data compare typical moisture absorption and vapor transmission values for a number of materials commonly used in pipe coating systems.

Material	Moisture Absorption (percent by weight)	Moisture Vapor Transmission Rate (grams per 100 sq in. per day)
Asphalts, modern type	0.9	...
Coal-tar enamels	0.2	...
Epoxy resins	0.05 to 0.10	...
Microcrystalline waxes	...	...
Polyethylene	0.01 to 0.02	0.4 to 0.6
Polyvinyl chloride	0.10 to 0.70	1.2 to 1.5
Vinylidene chloride	0.1	0.20
Cellulose acetate	2.0 to 4.0	...
Polypropylene	0.01	...

Resistance to Chemicals. While pipe coatings are normally not subjected to severe chemical exposures there are certain conditions which are not uncommon exposures for pipe:

Weak Acids	All commonly used pipe coating materials appear to be sufficiently resistant.
Weak to Moderately Strong Alkalis	Some cellulose acetate is softened, some of the early plasticized polyvinyl chloride tapes lost flexibility under these conditions. Other materials such as asphalts, coal-tar enamels, polyethylene, vinylidene chloride and microcrystalline waxes appear to be unaffected.
Hydrocarbons	Asphalts and to a smaller extent coal-tar enamels (depending on degree of plasticization) are softened by hydrocarbons such as gasoline. The plastic materials such as polyethylene, vinylidene chloride and polyvinyl chloride are generally resistant to hydrocarbons such as oil, gasoline, etc., which might be found in the soil but they are affected by some aromatic solvents.

Mechanical Properties. Mechanical properties that make for a good pipe coating are unfortunately not always published in the technical literature. What is needed is a material that will withstand handling and lowering operations (at various commonly encountered temperatures) and will withstand soil stresses after burial. Impact, abrasion and cold flow resistances are all important qualities in a coating.

The following data compares the impact resistance *(ASTM D-256, Izod)* of several of the plastic materials:

Material	Impact Strength (Ft-lb per in. of notch ½ in. by ½ in. bar)
Polyethylene (intermediate density)	0.5 to 5.5
Polyvinyl chloride, plasticized	test not applicable
Polypropylene	0.6 to 2.5

The abrasion resistance required of pipe coatings probably can better be described as a resistance to scuffing rather than the type of abrasion produced by *ASTM Test Method D-1242* in which a loose abrasive or bonded abrasive belt is brought into contact with the material under test. Abrasion is a complex phenomenon in which a number of qualities are involved.

As an example, the outstanding performance of some materials such as neoprene under sandblast conditions that will abrade away a steel surface but scarcely affect the neoprene. Yet we know that a bare steel surface would withstand being dragged along a pipe skid better than a thin coating of neoprene or other nonmetal.

Comparisons between materials are further complicated by the variety of thicknesses obtainable and by the presence of adhesives that act as cushions for the plastic backing on plastic tapes.

Cold flow — or creep — is defined as a *dimension change with time* of a material under load, following the initial instantaneous elastic deformation. Temperature, stress level, and presence of reinforcements, fillers or shields are all very important factors in determining the amount of cold flow that occurs. Unfortunately there is a lack of cold flow data on some pipe coating systems and, therefore, comparisons are difficult. It would be natural to assume that harder materials would exhibit less tendency toward cold flow than softer materials. This is not always the case as has been demonstrated for various coal-tar enamels. Both bituminous materials and plastics, when properly compounded, appear to be sufficiently resistant to cold flow for almost any soil conditions provided that use is made of reinforcements or shields.

Performance of pipe coatings at temperatures substantially above those normally encountered in soils is important at certain locations such as on the downstream side of gas compressor stations where the temperature may reach as high as 180 F. At these temperatures all coating materials including coal-tar enamels, asphalts, and thermoplastics tend to become less resistant to creep and, in addition, the primer or adhesive that attaches the pipe coating to the steel of the pipe itself is usually affected adversely.

It would appear that certain materials such as coal-tar epoxies or high density polyethylenes or propylene may offer a satisfactory solution to this problem. At this time, however, there is not sufficient long-time experience with some of these newer materials to predict whether or not they will be completely successful at these unusually high temperatures. It should be pointed out that the resistance to high temperature is only a necessity at a limited number of locations, most of which are connected with the natural gas or petroleum industries.

The relative importance of these various mechanical factors depends on whether the pipe is coated over-the-trench or whether it is coated at a mill located some distance from the job site. It is obvious that a coating that will be handled several times must have a greater resistance to impact and abrasion than a coating that will be immediately lowered into the ground and backfilled. Since handling, transporting, and lowering-in of the pipe are under control of the owner, it is very possible to institute measures that will prevent undue damage during these operations. The use of wide reinforced fabric slings, padded skids, and selected backfill such as sand are all currently accepted practices used in the industry for minimizing damage to coatings.

Furthermore, damage that occurs prior to or during backfilling operations can be detected by the use of high voltage holiday detectors or the Pearson over-the-ground method. It is of the greatest importance to have a coating that will remain the same year after year with very little change taking place. If the initial coating is of good electrical quality, is compounded of stable materials, and damaged places in the coating are repaired as the damage occurs, then the resulting coating should be good initially and should retain its excellence for many years to come.

Experience With Polyethylene and Polyvinyl Chloride as Pipe Coatings

Polyvinyl chloride and polyethylene self-adhesive tapes were first used as pipe coatings in about 1949. Typical usage was for wrapping small fittings on gas services and for wrapping welds on pipes having conventional tar or asphalt coatings. With the exception of a few small test installations, none of the early installations of plastic tape coatings were made in such a way as to make it possible to obtain electrical data.

The first sizable application of a pressure-sensitive plastic tape as a pipe coating was made in 1950. In this instance, the welded joints, turns and other fittings on several miles of 24-in. gas main in a large eastern city were hand-wrapped with 4-in. wide 10 mil PVC tape. No primer was employed but the pipe was mechanically cleaned and washed with methyl alcohol before the tape was applied. This material was selected over conventional bituminous coatings because of savings in time and labor as well as ease of application in difficult locations where pipe was buried deep. After 9 years, the tape is still standing up well with no evidence (electrical or visual) of deterioration. This utility company has continued to use the PVC tape but they now feel that a primer is a necessity because of dust conditions that otherwise prevents the adhesive on the tape from being entirely adequate.

In 1948 a pipe coating test program was inaugurated in low resistivity Houston clay. Included were a number of commonly used coating materials and some as-yet-untried plastic tapes that had just come on the market.

The following table shows the results of these tests on 1¼-in. by 3-ft pipe lengths. The pipes have been under continuous cathodic protection for a minimum of 9 and a maximum of 12 years. The pipes buried for 12 years had a pipe-to-soil potential of −1.7 volts the first year and −1.1 volts the second year. For the last 10 years, the pipe-to-soil potential on all specimens has been substantially constant at −1.0 volt to copper-sulfate electrode.

The current collected in microamperes per square foot and the resistance in ohms for 1 sq ft are the values measured at the end of the burial period indicated. The values in the last column are current requirements to obtain −1.0 volt potential on a mile of 30-in. pipe, assuming the collected currents per square foot are the same as the measured values on the specimens.

Coating	Years Buried	Current Collected Microamperes per sq ft	Resistance Ohms for 1 sq ft	Current Per Mile of 30-in. Pipe
Regular coal-tar enamel and asbestos felt	16[1]	4	5,400	0.16
Regular coal-tar enamel and asbestos felt	12	15	8,700	0.60
Asphalt mastic, ½-in.	12	0.2	250,000	0.008
Rubber tape, 40 mils	12	0.15	420,000	0.006
Rubber tape, 20 mils	12	0.40	150,000	0.016
Vinyl tape, 7 mils, and asbestos felt	10	0.30	200,000	0.012
Vinyl tape, 7 mils, and asbestos felt	10	1.0	210,000	0.04
Neoprene, 60 mils	10	9	21,000	0.36
Polyethylene tape, 9 mils	9	0.01	860,000	0.0004
Polyethylene tape, 9 mils[2]	9	10	6,000	0.40
Sandblasted bare pipe	10	400	12	16

[1] This specimen is 100 ft of 2-in. pipe buried 6 years before cathodic protection was applied. The other specimens are 1¼-in. pipe 3 ft long with cathodic protection applied immediately after burial.

[2] This sample damaged by stress cracking (tension too high) a characteristic of some of the early polyethylene tapes.

Cathodically protected lines are often subjected to potentials much higher than those necessary to control corrosion. Excessive cathodic protection potentials result in the formation of alkali and evolution of hydrogen gas at holidays and damaged areas in the coating. If the coating material is not highly resistant to alkali, the holidays and damaged areas will enlarge and expose more bare pipe to the soil, thereby increasing the current requirements.

Many coating materials such as coal tars, asphalts, rubbers, and polyethylene are sufficiently resistant to alkali so that damage is usually small. Severe damage can occur, however, to these coatings from the evolution of hydrogen gas when the pipes are located in low resistivity soil or water. The hydrogen evervoltage point for steel is in the vicinity of −1.1 volts to copper-sulfate electrode. Voltages of −1.5 volts or higher can be damaging to most coatings in the

vicinity of pinholes. The amount of hydrogen generated varies with the current so that in low resistivity soils or sea water the effects are pronounced.

The table below shows the results of accelerated tests made by Ebasco Services, Inc., in 1952 on intentionally damaged coal-tar and tape coatings in an electrolyte of 10 ohm-cm resistivity salt water. In the case of regular enamel only, much of the coating was destroyed after 3 months and the current collected began to approach that of bare pipe. Glass reinforcements and asbestos felt shields greatly reduced the damage to the coating. The vinyl tapes suffered some embrittlement due to the highly alkaline moisture that developed under the tape. As a result of these tests, changes were made in the PVC that appear to have eliminated the embrittlement problem. Increases in current in the order of 160 to 1 would be expected in the 1½-volt specimens due to the increased driving voltage. Increases exceeding a 160 to 1 ratio are largely the result of coating damage.

EFFECTS OF EXCESSIVE PROTECTION POTENTIALS ON PIPE SPECIMENS AFTER 7 MONTHS IN 10 OHM-CM SALT WATER

(All Coated Specimens Have 18 Artificial Holidays in Approximately 1½ sq ft of Coating)

Material	Ratio of Current Collected at −1.5 Volts to Current Collected at −1.1 Volts[1]
Bare pipe	157
9 Mil polyethylene tape	21.8
10 Mil polyvinyl chloride tape	60
Regular enamel plus reinforcement and shield	63
Plasticized enamel plus reinforcement and shield	66.7
Plasticized enamel plus reinforcement or shield	70
7 Mil polyvinyl chloride tape	286
Regular enamel plus reinforcement or shield	333
10 Mil polyvinyl chloride tape (different brand)	600
Plasticized enamel only	1,540
Regular enamel only	330,000[2]

[1]With respect to copper-sulfate electrode.
[2]Extrapolated 7 month value (ratio was 100,000 after only 3 months).

The above data can be interpreted as being a measure of the ability of a damaged coating to resist further damage by cathodically produced hydrogen or alkali. The lower the ratio of current collected at −1.5 volts compared to −1.1 volts, the better the coating performance with respect to this important characteristic.

In April 1953, N. P. Peifer presented a paper at the Distribution Motor Vehicles and Corrosion Conference of the American Gas Association in which the use of plastic tape was discussed. Mr. Peifer noted that 2½ years of soil stress tests on large diameter pipe in high shrinkage soil had caused no damage to 10 mil vinyl tape. The use of a primer was found to increase tape adhesion to pipe by as much as 500 percent and to decrease abrasion damage under grit blast test conditions. The use of tape for spot coating in severely corrosive areas was found to be more economical than either mill or over-the-trench application of conventional coal-tar enamel coatings.

In February 1954, the Seadrift Pipe Line Company built an 8-in. gas transmission line traversing gumbo and caliche soil having average resistivity at pipe depth of 1800 ohm-cm. The line was sectionalized by means of insulating joints. A conventional coal-tar enamel and felt coating was installed on 18 miles of the line. An adjacent section was machine cleaned and machine wrapped with an 8 mil film of poly-

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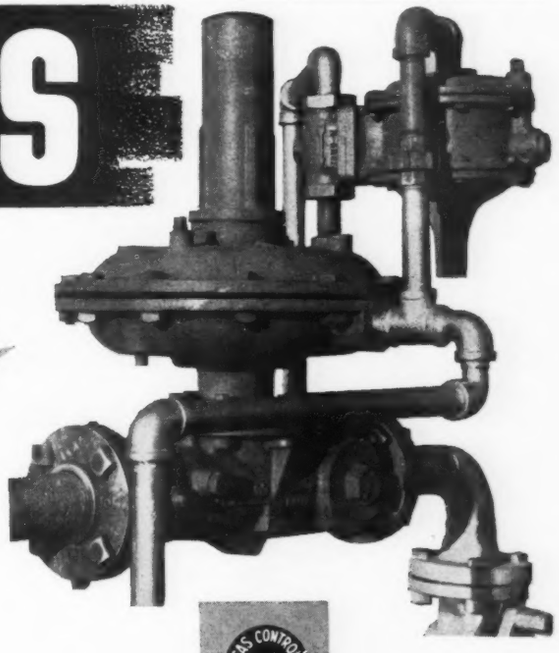

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ethylene followed by an unbonded outer wrap of coal-tar saturated asbestos felt. No primer was used under the tape. After 2 years' operation under moderate cathodic protection potentials, the current requirements for the two test sections were compared (after correcting for differences in average operating potential). It was found that the polyethylene tape coated section required only 7.33 ma per mile to produce a mean pipe-to-soil potential of 1.0 volt to a copper-sulfate electrode whereas the coal-tar coated section required 22.5 ma per mile to achieve the same results*.

In 1956, the entire length of a 122-mile, 22-in. pipeline connecting the American Louisiana Pipe Line Company system with the Michigan Wisconsin Pipe Line Company system was coated with an 8 mil polyethylene tape except on river crossings and densely populated areas, where a 15 mil polyethylene film was used. No primer was used but there was an outer wrap of standard 8-lb asbestos felt.

In his article describing this job (*Pipeline Engineer*, November 1956) Donald M. Taylor enumerates a number of advantages of the polyethylene tape over conventional coatings. They are:

1. Coating and lowering-in operations could be combined thus saving equipment and labor. Decrease in laying cost was sufficient to offset higher cost of polyethylene plastic tape.

2. Holidays are few and can be readily patched in a matter of seconds.

3. Coating can be cradled directly into the ditch instead of onto skids for cooling.

4. Small gangs can coat the pipe at high speed.

5. Coating material comes in light packages, is easily handled by hand and is ready for application without heating.

Henry M. Clayton of the Memphis Light, Gas and Water Division reported in the September 1956 issue of *Corrosion* magazine on "Testing Wrappings on Cathodically Protected Submerged Pipe and Fittings." Mr. Clayton's main concern was the applicability of plastic tapes to fittings and joints in lieu of hot coal tar, which was unpleasant to handle and was hazardous as well. The test setup employed by Mr. Clayton and his colleagues consisted of a plastic box full of 2000 ohm-cm water in which were placed two short pieces of 1-in. pipe joined by a 90 degree elbow. Measurements of current collected were made weekly and at the same time the cathodic protection potentials were increased. At the end of the test program several conclusions were drawn among which were the following:

1. The effectiveness of the adhesive used was probably one of the major factors in determining the current limiting ability of the tape. Without an effective adhesive, the tape could creep and allow the passage of water and current between the overlapping layers.

2. Even a good adhesive, however, cannot compete with the pull of a very elastic tape at the end of the windings unless very great care be used in applying it without stretch.

3. Another factor that was found to be very important was the memory of the tape, that is the tape's desire to return to its original flat and straight condition. The poorer the memory the better results obtained especially around irregular objects such as pipe fittings. . . . This factor is not believed to be of as much importance, however, when tapes are applied on longer runs of straight pipe only.

4. Poor results were obtained with all 20 mil tapes. The

*A complete description of the installation can be found in the January 14, 1957 issue of the *Oil and Gas Journal* in an article "Polyethylene Tape Proves Value" by Marshall E. Parker.

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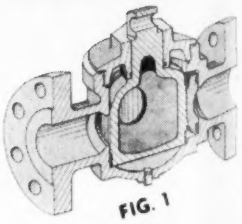

FIG. 1

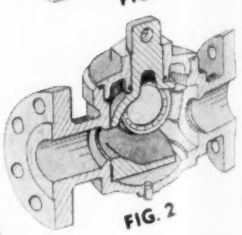

FIG. 2

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stiffness due to extra thickness evidently resulted in the inability of such a tape to accommodate itself to a 1-in. pipe and fittings.

On the basis of the test program at least one 10 mil plastic tape was approved for use. It should be remembered that Mr. Clayton's program was designed to test the wrapping of small fittings and not straight piping runs and that recently, grades of plastic tape having high conformability have become available.

Just recently a major pipeline system owned by the Houston Texas Gas & Oil Corporation was constructed in the states of Louisiana, Mississippi, Georgia and Florida. The system comprises some 1570 miles of pipeline, most of which is in the size range of 18 to 24-in. The entire system was wrapped with a layer of polyethylene tape over which there is an asbestos felt overwrap. No primer was employed. Polyethylene tape was chosen for this job largely on the basis of economy of installation and economy of operation as reflected in predicted cathodic protection current requirements.

It was estimated that the use of the tape would save over half a million dollars in comparison with competitive bituminous coatings. This saving, the engineers estimated, would be partly in labor and partly in equipment. Nineteen men could do work formerly requiring 36 men, and it was estimated that 7 construction equipment units would be required as contrasted with 18 units if a conventional hot-applied coating were employed. Initial coating resistance after backfilling was reported as "over 1,000,000 ohms per sq ft."

As of the present time most of the major gas utility companies and gas transmission companies are either making regular use of plastic tape coatings or have installed test sections for observation.

Comparison of Plastic Tape Coatings With Bituminous Coatings

Previous sections of this report have dealt with specific properties of coating materials, but in the final analysis there are other factors that sometimes govern the acceptance or rejection of such a product. Among these factors are cost, skill required for application, effects of weather on coating operations, safety, and public relations.

Cost. Simplicity and ease of application have been responsible for most tape used as a pipe coating material prior to about 1957. Labor costs and the cost of bituminous coating materials have been gradually increasing, whereas the cost of plastic pipe wrapping tapes has decreased sharply in recent years so that, in 1960, there appears to be a slight cost advantage in favor of certain plastic tapes for over-the-trench applications, at least in some areas.

The best cost analysis available at this date is for the new Houston Texas Gas and Oil Corporation pipeline system between Baton Rouge, Louisiana and Miami, Florida. The main line of this system totals over 900 miles in length and consists of 18 to 24-in. pipe, all of which is being wrapped with a pressure-sensitive polyethylene tape (14 mils thick including adhesive), and overwrapped with a layer of 15-lb asbestos felt.

Preliminary economic comparisons between coal-tar and polyethylene tape for this job showed tape and felt material costs amounting to $3149 per mile as compared to only $2351 per mile for the coal-tar coating system. It was reported, however, that the use of tape enabled savings of $1310 per mile in labor and equipment costs. The net result was an estimated saving of over $500 per mile through the use of tape. It should be pointed out that, had a primer been used with the tape, the savings probably would have been only $300 per mile.

For minor coating jobs at remote locations, there seems to be no doubt that the tape coating would be cheaper because of the small amount of equipment required and the light weight of the tape coating materials.

Skill Required for Application. To some extent, the quality of all pipe coatings is dependent upon the proficiency of the applicator. The more involved the operation, the greater the likelihood that mistakes will be made or corners cut in order to save the contractor's money.

In the case where the coating is a plastic tape the application procedure is simple and consists of mechanical cleaning, and the spiral application of tape over the pipe. In certain jobs, pipe will be initially primed with a quick drying primer and a spiral of felt will be overwrapper on top of the tape. There are now available machines that can handle these operations at rates that equal or exceed the rate of construction of other gangs, such as trench diggers and welders. About the only limitation placed on taping operations is that the pipe must be clean and dry.

Conventional hot applied coatings such as coal-tar enamel or asphalts are good basic materials but they do require more skilled personnel and heavy equipment than do the plastic tapes. Coal tar, for example, must be applied at a temperature that is usually on the order of 400 F and at the same time this temperature must be kept under control so that the coating thickness will come out as planned. If the bituminous material is heated to too high a temperature or is kept at application temperature for too long a time the end result will be a brittle coating that may contain small coke particles. These particles not only degrade the coating but can actually set up strong galvanic cells that act to cause corrosion of the pipe.

Another complication is that the primers used with hot applied bituminous materials often take several hours to dry properly. If the primer is allowed to dry for too long a period it loses its "life" and the pipe must be reprimed. Failure to observe proper drying time can result in a lack of bond between coating and pipe.

It should not be implied that the hot materials are never applied correctly as this is not the case. There are, in fact, a number of well-qualified contractors and coating mills who are capable of doing a first-class coating job with the hot materials. These firms should be given the job of applying the hot materials. Unfortunately there are some utility companies whose ambitions exceed their ability with respect to applying pipe coatings. It should be stressed that the application of coal-tar enamels or asphalts is not a field for amateurs regardless of where the application takes place.

Plastic pressure-sensitive tape is being used to apparent economic gain on all sizes of pipe. It is believed that plastic pressure-sensitive tapes can be employed to advantage in the many locations where pipe or joint coatings are normally applied by casual labor under a minimum of qualified supervision.

Mill-coated pipe can be used successfully provided that outdoor storage of the coated pipe is not too prolonged and that proper methods of handling and transporting the coated pipe are employed. In the cases where mill-coated pipe is employed, it is necessary to field-wrap the joints whether they be welded or coupled by some other method such as a mechanical compression-type coupling.

Effects of Weather. Weather has a greater effect on the application of conventional hot applied coatings than on tape applications for several reasons. First, the start-up time necessary for the application of hot coatings is much greater than for tape coatings. For example, it often takes 3 or 4 hours to bring the dope kettles up to proper operating temperature from a cold start.

If a sudden storm comes up in the middle of coating operations the applicator has a choice either of dumping the

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hot materials on the ground where they are completely wasted or of keeping the material hot until weather improves. If the latter is done, it is quite possible that the coating material will become degraded. If, on the other hand, a working day starts out with rain in the morning and suddenly clears in the middle of the day, it is often too late to get hot coating operations under way before the close of the working day.

When tape is used, however, start-up time is virtually nil. All that is required is that the pipe be clean and dry. In areas that are subject to trench collapse under wet conditions, the contractor likes to keep the work spread as short as possible so that sudden rain spells will not slow down operations. In the cases where tape is used the total working distance between line-up operations and backfilling operations can be made as short as 250 ft, which means that at any given time the contractor has a minimum of open trench that is vulnerable to flooding and cave-in.

When conventional hot materials are used, pipe coating operations can become a bottleneck to hinder the progress of the job. When this occurs there is a natural tendency on the part of some contractors to avoid delays by cutting corners in such ways as priming over wet pipe or coating over a primer which has not been allowed to dry sufficiently. None of these temptations need worry the tape applicator as taping operations are relatively rapid and do not tend to hold back other construction operations.

Safety. Safety is always an important factor on any construction job. There can be no argument that hot coal tars and asphalts are potentially dangerous materials if spilled upon workmen. The high temperatures involved and the quantities of irritating vapors given off by the hot coal-tar kettles make working conditions unpleasant, particularly in hot climates.

The vapors given off by hot coal tar have the ability of sensitizing the skin to the effect of ultraviolet light to such an effect that a severe sunburn can be picked up in a relatively short time working adjacent to the hot kettles. Bituminous materials come in large drums frequently weighing as much as 600 lb. The handling of these drums presents a certain hazard compared to the tape-coating rolls that only weigh up to about 40 lb each, depending on tape width. With proper precautions the additional hazards involved in the use of a hot material can be minimized but it requires vigilance to do so.

Public Relations. One of the important intangible factors that utility companies must keep in mind is the relationship they have with the general public.

This is a complex factor involving safety, job appearance, delays, inconveniences, and damage to private property. The faster a job can be completed, the better it is as far as the public is concerned. A contractor using tape is able to confine operations to a relatively small area and he requires fewer men, less equipment, and no messy hot kettles of bituminous materials. In addition, at the conclusion of the job, there is a minimum of waste material left on the ground since the percentage of material wasted is much smaller with tape than with coal tar or asphalt.

Acknowledgment

This article developed from a comprehensive report prepared by Ebasco Services, Inc., New York, New York, in cooperation with the Seamless Rubber Company, New Haven, Connecticut.

* * *

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Pneumatic drills cut through four feet of rock to prepare firing bed for dynamite charges during construction of Union Gas Company's Owen Sound distribution system in Ontario. More than 5000 lb of dynamite — all in small charges — was used to move some 900 cu yd of rock. Majestic Contractors, Ltd., installed the 202,000 ft of 1 through 6-in. piping in rapid time despite the rock problem.

Alongside Massachusetts Route 110, the Haverhill road, a 55-ft length of coated 12-in. pipe is lowered-in by a sideboom tractor during installation of 12,240 ft of 8 and 12-in. line for Haverhill Gas Company. Bond Brothers, contractors, averaged 1000 ft of pipe every 10 hours on the job. New line will tie in with existing distribution lines and provide additional gas supply for the communities of Amesbury, Salisbury, and Newburyport.

DISTRIBUTION DEVELOPMENTS

NEWS ABOUT CURRENT AND PLANNED CONSTRUCTION

Alabama Gas Corporation, Birmingham, Alabama, plans to spend approximately $4,923,000 on new construction in 1960. Of the total, $2,824,000 will be spent in and around Birmingham. Major portion of the 1960 expenditures will be used to bring service to additional customers. Company spent $4,901,000 on construction and new facilities in the fiscal year ended September 30, 1959. Recently Alabama Gas completed a $32,000 10-in. main relocation project just south of Oxford on the main feeder line serving Anniston and Oxford because of proposed road construction. An old 6-in. main, that had been in service since 1930, was abandoned.

Southern California Gas Company, Los Angeles, California, plans to spend $12,400,000 in 1960 to cover addition of mains, meters, and services to supply new customers. This figure is based on an estimate of 66,000 new meter outlets being added during 1960 with a net connected meter gain of about 51,000. Approximately $8,400,000 has been allocated for improvements and replacements. More than $1,000,000 has been allocated for improvements of underground storage facilities at Playa del Rey. Other major budget items include $1,700,000 for motor transport, furniture, equipment, etc., and $600,000 for buildings, alterations and improvements. This latter figure is the lowest in recent years since there are no new major buildings planned for construction this year by the company.

San Diego Gas & Electric Company, San Diego, California, plans to spend approximately $15,157,000 for new gas department construction in 1960. Major project for the year is a proposed Rainbow to San Diego gas supply line that will cost approximately $8,300,000. Company's preliminary construction budget for 1960 is considerably larger than any previous budget in the company's history.

Atlanta Gas Light Company, Atlanta, Georgia, plans a $1,500,000 expansion of its Riverdale refrigerated peak-shaving plant with construction getting underway in early 1960 in preparation for the 1960-61 winter. Two new 1,290,000-gal capacity storage tanks, a 1500 hp compressor, and a gas-fired vaporizer will be installed. Estimated completion date for the first tank is next summer, and for the second tank next fall. New construction will bring dollar investment in the peak-shaving plant to $4,600,000, increase its daily processing capacity to 68,600 cu ft, and increase storage capacity to 6,455,000-gal in five tanks. Also scheduled for 1960, Atlanta Gas plans to construct a new 85,000 sq ft five-story building at Caroline Street at Moreland Avenue in Atlanta. Accounting operations now located in the Whitehead building and several departments from the main office, including engineering, customer service, collectors, and addressograph room, are scheduled to move to the new building. Contract has been let and actual construction will get underway in early spring.

Iowa-Illinois Gas and Electric Company, Davenport, Iowa, has applied to the Federal Power Commission for authority to build 26 miles of natural gas feeder line from west of Muscatine, Iowa, to Wilton and West Liberty, Iowa. Request has also been made to connect the feeder line to the transmission pipeline of Natural Gas Pipeline Company of America. An application for a permit to "construct, operate, and maintain," the supply line to serve Wilton and West Liberty has also been filed with the Iowa Commerce Commission. This construction project, including distribution facilities within the two towns will cost approximately $1,000,000. Construction is dependent upon approvals of the two commissions and availability of steel pipe. Necessary city franchises were voted on and approved in August 1959. Approximately $600,000 has been budgeted for 1960 for a new metering and regulator station, main replacements and extensions and other betterments to improve service in Cedar Rapids and Marion. Approximately $250,000 has been budgeted for the Ottumwa area to build a new 6-in. intermediate pressure main and construct facilities to serve the towns of Fremont, Wright, and Cedar.

Northern Ontario Natural Gas Company, Toronto, Canada, has completed an 11-mile service lateral to serve the Canadian Johns-Manville Company's Munro Mine with 1,000,000 cu ft of natural gas a day. Contractor for the project was Nosov-Pedskalny Limited.

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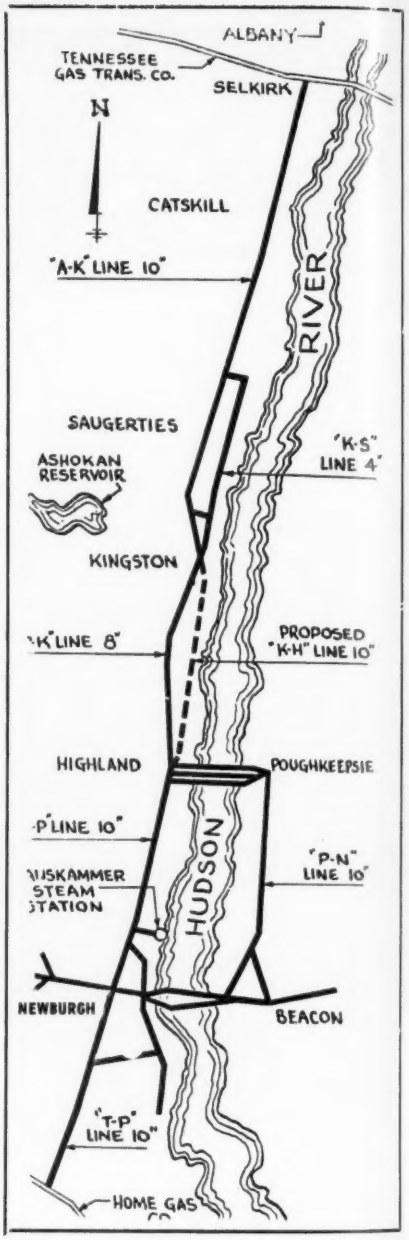
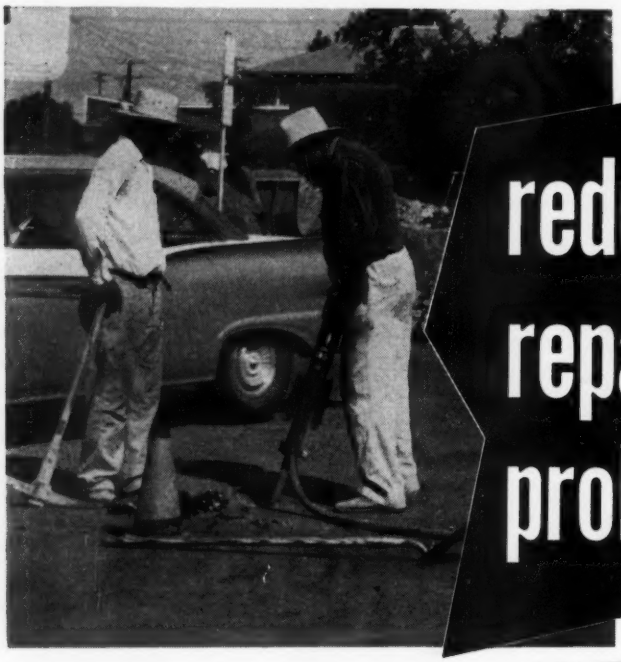
Distribution Developments

Central Hudson Gas and Electric Corporation, Poughkeepsie, New York, has budgeted $605,000 for extension of gas service to new residential and commercial customers throughout the system during 1960. Relocation of electric and gas lines along public roads due to highway construction programs by city, state, and federal authorities will involve an expenditure of $325,000 this year. Largest single construction project in the 1960 budget is installation of a 16-mile 10-in. Kingston-Highland line to acquire additional supplies of natural gas from Tennessee Gas Transmission Company. In addition to reinforcing gas supply to the area where Central Hudson's greatest gas load is concentrated, the new line will enable greater use of natural gas as a fuel at the Danskammer Point Steam Station during "off-peak" periods. It will also allow an existing 8-in. Poughkeepsie to Kingston line to be used as either a natural gas supply line or to transmit a mixture of natural gas and manufactured gas from the Poughkeepsie Gas Works for distribution to the Kingston area during "peak-shaving" periods. Acquisition of rights-of-way and the necessary land purchases have been completed. Clearing and grading of the route was started in February and actual construction will get underway in early spring. The new line, designed to the same specifications as the Albany-Kingston line built in 1957, will tie into the Tuxedo-Poughkeepsie line at Highland, completing the establishment of a 10-in. high pressure supply system extending from the north end of the company's **franchise area near** Albany to the south end near Tuxedo. The new line begins near Port Ewen, runs generally parallel to the west bank of the Hudson River, and will terminate at the Highland regulator station. Construction of the line and its terminal stations is expected to cost $1,172,000. The line itself is estimated to cost approximately $870,000.



Map shows location of new 10-in. Highland-Kingston supply line in relation to Central Hudson Gas and Electric's other supply lines. New line will allow existing 8-in. line to carry either natural gas or a mixture of natural gas and manufactured gas from the company's Poughkeepsie Gas Works for distribution to the Kingston area during peak shaving periods.



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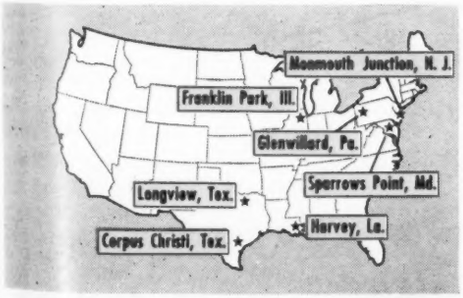

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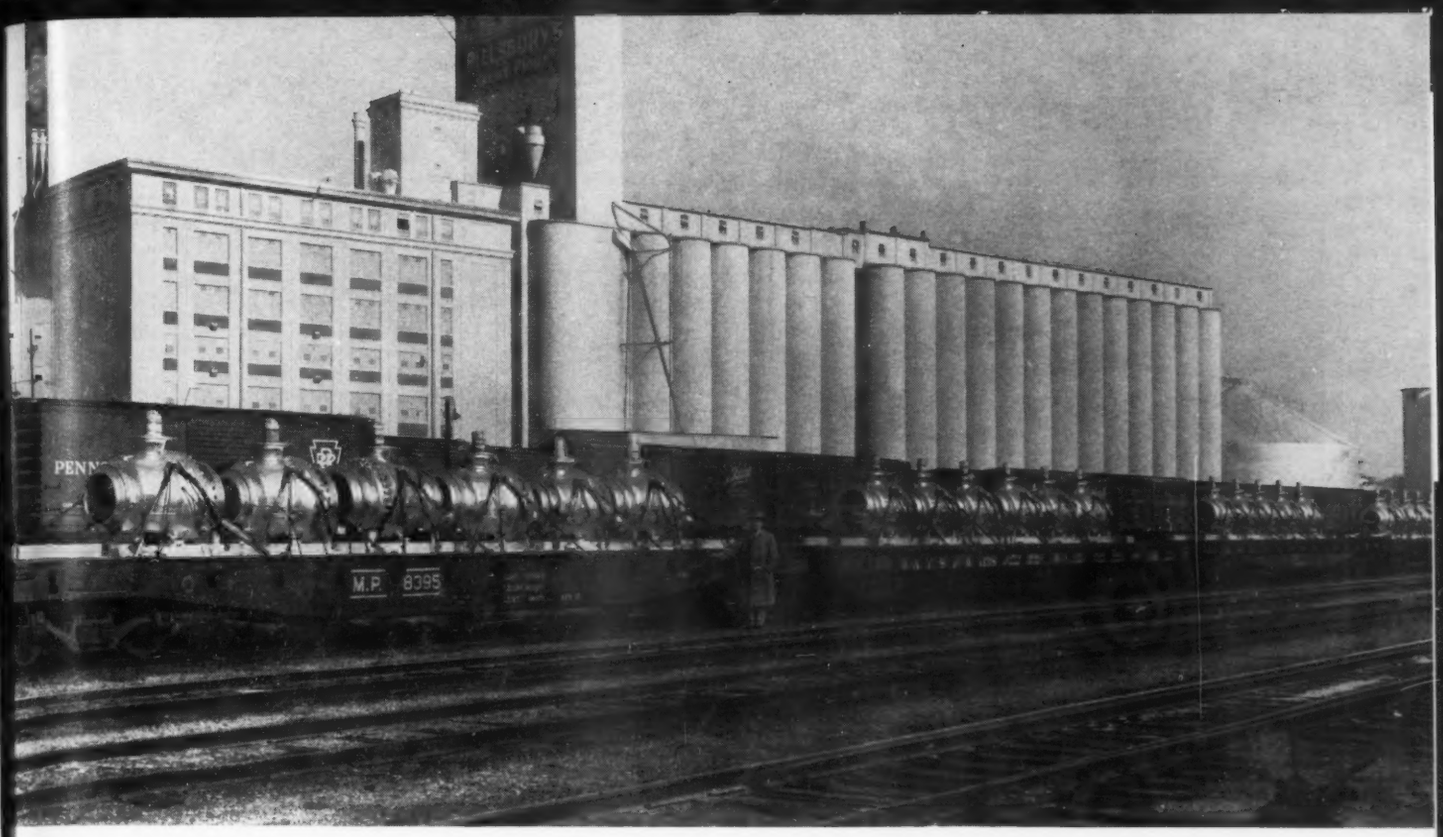
Distribution Developments

Michigan Consolidated Gas Company, Detroit, Michigan, plans to spend $22,238,000 on new facilities and equipment in 1960. The major construction budget is coupled with an increase of 28 percent in the utility's supply of gas. Michigan Wisconsin Pipe Line Company, an affiliate, is seeking regulatory authority to enlarge its system to purchase 333,000,000 cu ft of gas per day from sources originating in western Canada, Oklahoma, and Texas. Michigan Consolidated expects to receive 40 percent of this gas, about 135,000,000 cu ft a day. Michigan Consolidated will construct 217 miles of gas mains in its districts throughout the state; and expects to add approximately 16,000 new gas customers during the year. About 58 percent of the budget, $13,096,000, will be spent in the Detroit area where the company will install 77 miles of gas mains. This tops last year's expenditures by $2,200,000. In addition, the company will begin construction of its new 32-story central office building in Detroit's Civic Center this spring. Relocation of gas mains due to expressway construction will cost the company over $1,500,000.

In the Grand Rapids district, Michigan Consolidated will spend $2,834,000 and construct 59 miles of mains. Expansion in Ann Arbor will cost $1,355,000 and require 26 miles of mains. The Muskegon district will install 24 miles of mains and spend $612,800. Construction budget for the Northern districts, including Mt. Pleasant, Greenville-Belding, Ludington, Big Rapids, Cadillac and Traverse City totals $1,337,663 with some 31 miles of mains to be installed. Developing new underground storage facilities in the company's Six Lakes Storage District in central Michigan will cost $1,885,000.

Arkansas Louisiana Gas Company, Shreveport, Louisiana, has construction underway to extend gas service to four Arkansas towns — Glenwood, Amity, Norman, and Mount Ida. Approximately 30 miles of 6-in. line has been installed from southwest of Hot Springs to Glenwood and 8 miles of 3-in. supply main installed southeast of Glenwood to Amity. Mains and service line installations in both Glenwood and Amity have been completed. Approximately 22 miles of 4-in. is being installed northwest of Glenwood to bring natural gas to Norman and Mount Ida.

Montana-Dakota Utilities Company, Minneapolis, Minnesota, plans to install approximately 3 miles of 14, 12, and 10-in. mains in Billings, Montana. Contract has been let to J. W. Albrecht Construction Co. of Bridges, Mont.



Flat carloads of Rockwell Hypresphere valves ready for shipment to a western gas transmission company.

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The trainload of Rockwell Hypresphere lubricated spherical plug valves (above) is dramatic evidence of the immediate acceptance of this valve by oil and gas pipeline engineers. Introduced just a little over a year ago (after three years of rugged field testing) the Hypresphere has been specified on most of the big, new pipeline jobs. Why?

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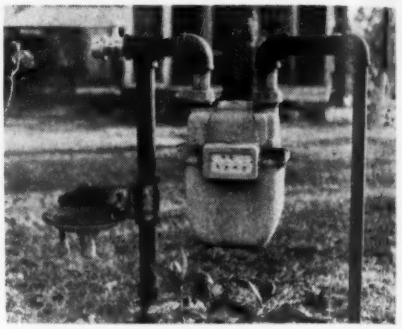
RCA WHIRLPOOL's three recently introduced 13-cu ft model "No Frost" gas refrigerator-freezers have eliminated the problems of frost accumulation in both freezer and food compartments. All have thin-wall urethane foam insulation, "million magnet" door gaskets for positive sealing, and squared-off architectural styling to permit installation flush to side walls and back. Introduction of the new models early in 1960 means Whirlpool has already beaten its own timetable by a whole year. When it acquired the facilities and patents of Servel early in January 1958, it announced a 3-year program of engineering and research to create a unit comparable in efficiency and features to its electric models. The new 1960 refrigerators, after less than 2 years of intensive development, represent some startling and basic improvements. Previous models incorporated an absorption system that weighed 175 lb and required 141 welds; in the 1960 models, absorption system weight has been reduced 50 percent and the number of welds 30 percent. New units consume less gas than their predecessors and are constructed so that warm air is exhausted at the base of the refrigerator instead of out the top rear. Urethane foam insulation used in the new models is approximately twice as efficient as the insulating material previously used in gas refrigerators. Units may be installed with only 4 in. clearance between top and ceiling or wall cabinets. No clearance is required on sides and at back.

CIRCLE (61) ON THE REPLY CARD

DESIGNED PRIMARILY FOR UTILITIES and similar companies that monitor and control unattended locations remotely from a central control point, a new alarm/control system has been placed on the market by General Electric Communication Products Department. New equipment may be used with microwave, carrier current, or wire lines. Control signals employed are in the form of tones. They may be used to check a single location or as many as 100 different points. Ten functions may be checked at each point. The signals indicate whether a certain pre-scheduled action is taking place at a remote location or whether faults have occurred. At the control terminal, a small console mounted on the operator's desk has a bank of 10 indicator lamps to show the stations being selected and a second bank to show whether any faults are present. Dial is employed to select and check the desired station and operate remotely-controlled equipment at unattended points.

CIRCLE (62) ON THE REPLY CARD



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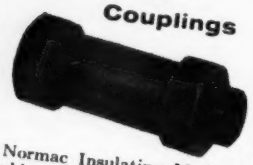
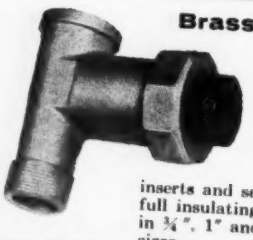


Normac Insulating Malleable Couplings and fittings are available with polyethylene inserts and semi-insulating gaskets or full insulating rubber gaskets.

Brass Fittings



Normac insulating Brass compression end Tees, Ells and all compression end fittings are available with polyethylene inserts and semi-insulating or full insulating rubber gaskets in ¾", 1" and 1¼" iron pipe sizes.

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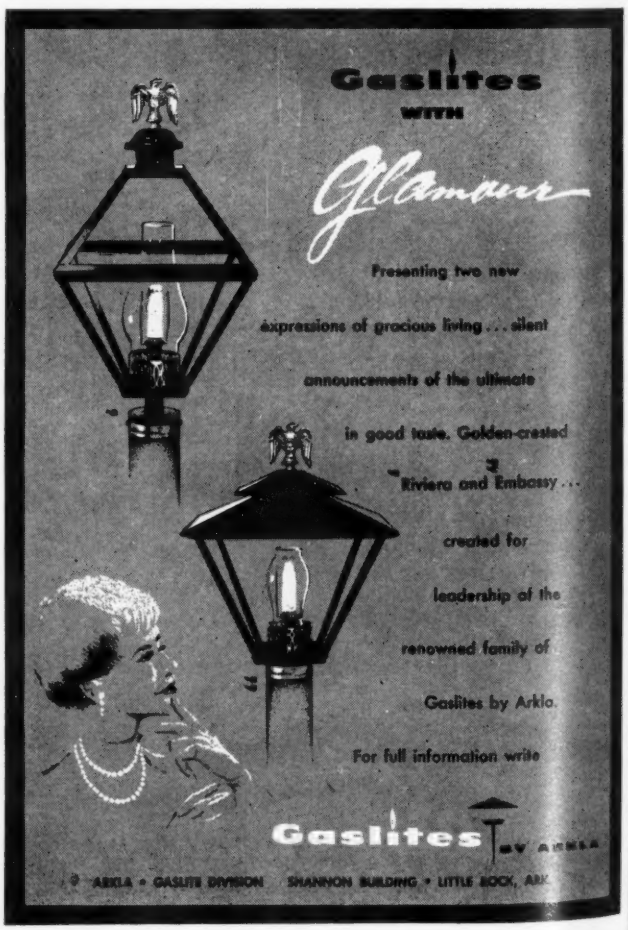

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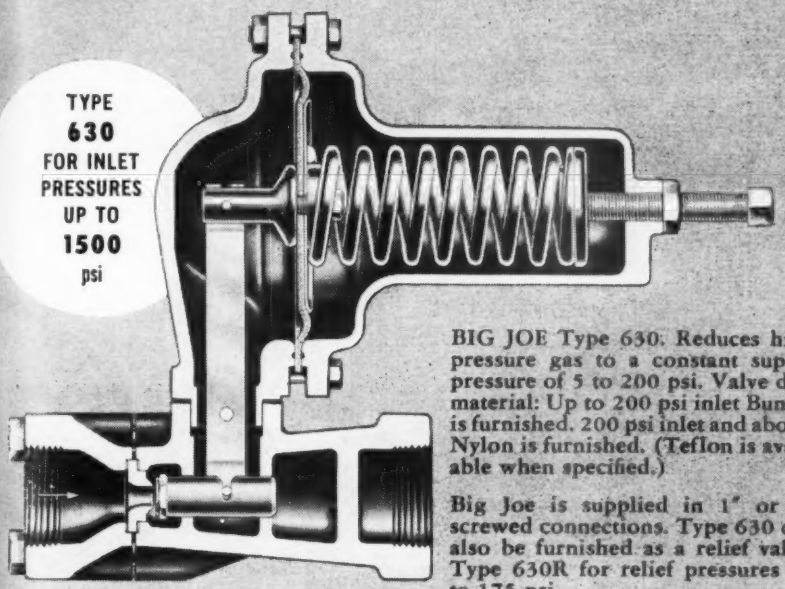
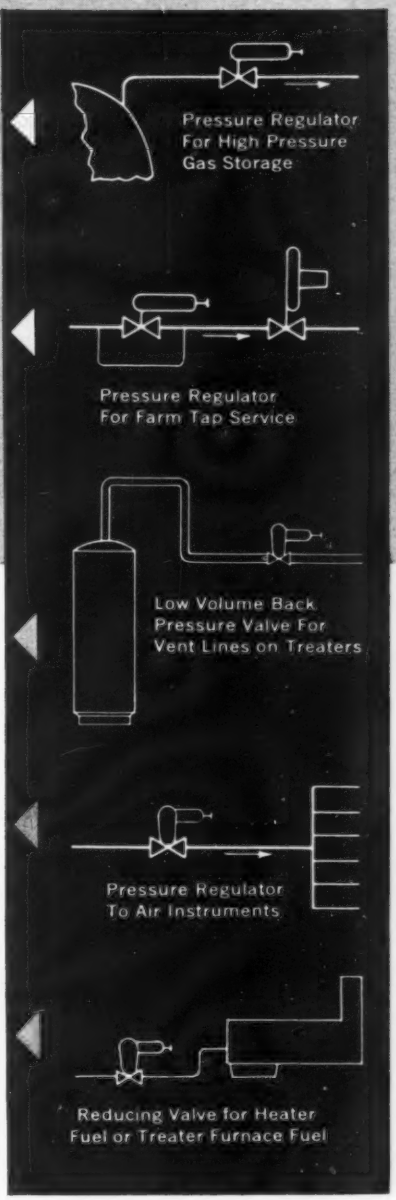
- Designed for dollar saving installations

TYPE 630 FOR INLET PRESSURES UP TO 1500 psi



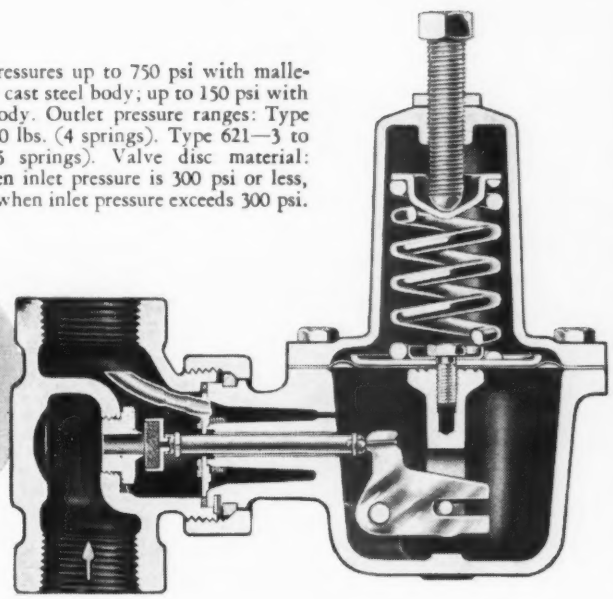
BIG JOE Type 630. Reduces high pressure gas to a constant supply pressure of 5 to 200 psi. Valve disc material: Up to 200 psi inlet BunaN is furnished. 200 psi inlet and above, Nylon is furnished. (Teflon is available when specified.)

Big Joe is supplied in 1" or 2" screwed connections. Type 630 can also be furnished as a relief valve, Type 630R for relief pressures up to 175 psi.


Pressure Regulator For High Pressure Gas Storage
Pressure Regulator For Farm Tap Service
Low Volume Back Pressure Valve For Vent Lines on Treaters
Pressure Regulator To Air Instruments
Reducing Valve for Heater Fuel or Treater Furnace Fuel

For inlet pressures up to 750 psi with malleable iron or cast steel body; up to 150 psi with cast iron body. Outlet pressure ranges: Type 620—3 to 60 lbs. (4 springs). Type 621—3 to 100 lbs. (5 springs). Valve disc material: BunaN when inlet pressure is 300 psi or less, and Nylon when inlet pressure exceeds 300 psi.

TYPE 620 FOR INLET PRESSURES UP TO 750 psi



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FISHER GOVERNOR COMPANY

Coraopolis, Pa. / Woodstock, Ontario / London, England

Main Office and Plant: MARSHALLTOWN, IOWA

FISHER® Controls

SINCE 1880

Why Pay More for a Trench than You Have to?

You don't have to buy the most expensive machine to get the most profit from your trenching. The Auburn Gear-Draulic Trencher has a low initial cost, yet does a superior job of digging. In fact, it will work in soil where others can't even start. Because of its simple, rugged design and variable speed hydraulic drive, it requires little maintenance and seldom has any down time. One man operates it and it handles up to 800 feet per hour. Digs 6″ to 14″ wide down to 6′ deep. It's the most profitable trencher you'll ever own, ask any Auburn owner.

AUBURN
TRENCHERS

Available for Massey-Ferguson, IH Utility, Ford, John Deere Crawler and Wheel Tractors. Jeep-A-Trench, only Trencher approved for Jeeps by Willys Motors.

WE TRENCH THE EARTH

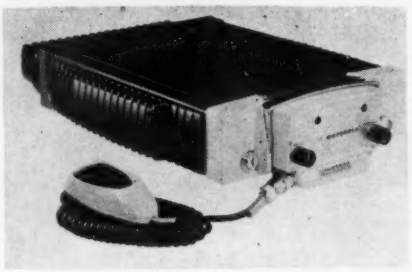
AUBURN MACHINE WORKS, INC.
2000 South 'J' Street
AUBURN, NEBRASKA, U.S.A.

Send me more information on the Auburn Gear-Draulic Trencher for a_____ tractor ☐, or on the Jeep-A-Trench Model ☐.

NAME_____

ADDRESS_____

TOWN_____ STATE_____

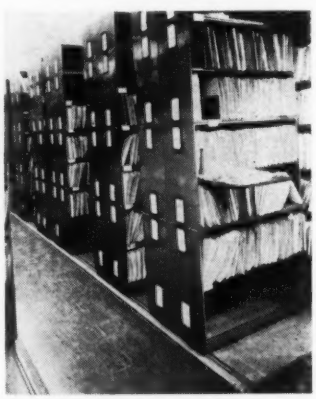


MOTOROLA is expanding its line of MOTRAC two-way radios to provide the highest powered transistorized equipment available that will accommodate either positive or negative vehicular battery ground polarity. Models will operate from either 6 or 12 v sources. New line is to consist of 25 watt and 50 watt models for the low band (25-54 mc) frequencies, and 30 watt, 60 watt, and 80 watt models for the high band (144-174 mc) frequencies.

CIRCLE (64) ON THE REPLY CARD

SMALL ROTARY GAS METER for line mounting recently introduced by Roots-Connersville Blower Division of Dresser Industries, is a compact, low capacity, positive displacement, rotary-type unit suitable for measuring commercial or industrial loads at pressures up to 125 psig. New unit can be flange mounted in either a horizontal or vertical gas line without need for additional support, and provides straight-through gas flow. A flow range to 3000 cfh, combined with a working pressure rating of up to 125 psig, allows the meter to be used for measurement of many industrial and commercial loads for which rotary-type meters have not previously been available. The permanent and non-adjustable accuracy feature claimed for the Roots rotary positive principle also makes the new gas meter well adapted for service in remote or unattended locations.

CIRCLE (65) ON THE REPLY CARD



MOBILE OPEN SHELF FILES that provide almost twice the filing system of standard steel drawer files are described in recent literature from Dolin Metal Products, Inc. Several rows of the mobile Dolin Open Shelf Files almost double original file capacity yet the same number of file clerks can control these highly active central files. New double face shelf files are easy to roll along floor tracks. Mobile units roll easily at any point to provide access to any rear file. Dolin Shelf Files are 1 and 2 shelf high units interlocked together to 7 shelves high.

CIRCLE (66) ON THE REPLY CARD

ELIMINATE
MAJOR REPAIRS
WITH
AMERICAN®
WELDED
STEELCASE METERS

- Tinned Steelcase Accuracy
- Hardcase Durability
- Maintenance Economies

American Welded Steelcase Meters provide a new approach to the economics of meter maintenance and retirement. Major repairs are eliminated. Minor adjustments are easy to make – assuring long service life at lowest maintenance costs.

Ask your American Meter representative for full details about Welded Steelcase Meters and their many advantages for all fuel gas services.

W-75	Rated cap. 75cfh — FOB Philadelphia
W-175	Rated cap. 175cfh — FOB Fullerton, Cal.
W-210	Rated cap. 210cfh — FOB Philadelphia
W-250	Rated cap. 250cfh — FOB Philadelphia
W-300	Rated cap. 300cfh — FOB Philadelphia
W-45-LPG	Rated cap. 45cfh* — FOB Philadelphia
WC-45-LPG	Rated cap. 45cfh* — FOB Philadelphia

*propane

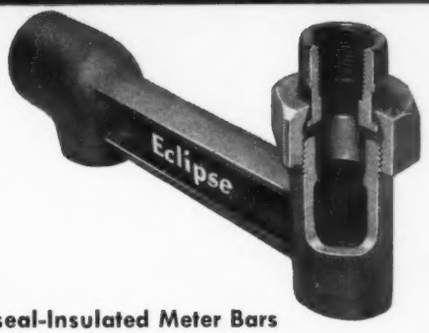
Rated capacities at ½-inch w.c. differential with 0.64 sp. gr. gas – 5 psi working pressure.

AMERICAN®
METER COMPANY
INCORPORATED (ESTABLISHED 1836)

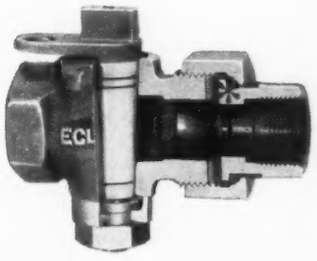
General Offices:
Philadelphia 16, Pa.

Sales offices
in principal cities

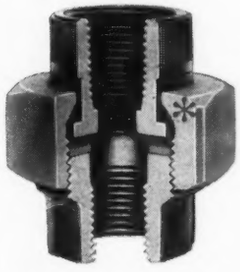
4-Ways Better Insulation against house currents



Wedgeseal-Insulated Meter Bars
— for tin (5-Lt through 30-Lt), aluminum and iron case meters in variety of connection sizes, with or without integral gas cock.



Wedgeseal-Insulated Gas Cock
— offered in lock wing and flat head styles, standard and "Retained Key" (tamperproof) construction. In ¾", 1", and 1¼" sizes. Individually tested with 125-lb air under liquid.



Wedgeseal-Insulated Union
— available in ⅜", ¾", 1", and 1¼" sizes. Recommended for working pressures up to 150 psig.

ECLIPSE *Wedgeseal*® INSULATOR

1 **CAN'T BE LEFT OUT**—it is integral with the tailpiece.

2 **WON'T SHEAR OFF**—has exclusive wedge design that withstands 350 ft-lb torque without damage.

3 **WON'T DETERIORATE**—nylon (Zytel 105) is not affected by natural, manufactured, or LP gas; is form stable at 400° F, and suitable for continuous operation at 275° F.

4 **SIMPLIFIES INSTALLATION**—assembly of insulation is eliminated, and Wedgeseal-insulated gas cocks and meter bars reduce number of threaded fittings and make-up time.

Add it up—4-way protection against metal-to-metal contact, against shorting or jumping. Wedgeseal is the strongest, simplest, most economical insulator you can use. Prove it out at no cost—send for a free Wedgeseal-insulated unit today. Use the convenient coupon.

Eclipse®

UNIONS • GAS COCKS
METER BARS

GAS SERVICE PRODUCTS DIVISION
Eclipse Fuel Engineering Co.
1108 Buchanan St., Rockford, Illinois

Please send me free of charge the following Wedgeseal-insulated unit:

UNION Size.....

GAS COCK Size.....Retained Key.....Lock Wing.....
Standard.....Flat Head.....

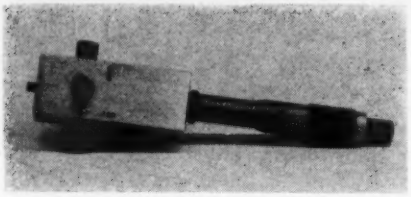
METER BAR No..... ..... x ..... for ☐ tin, ☐ aluminum or iron case.

NAME.....

COMPANY.....

STREET.....

CITY.....STATE.....

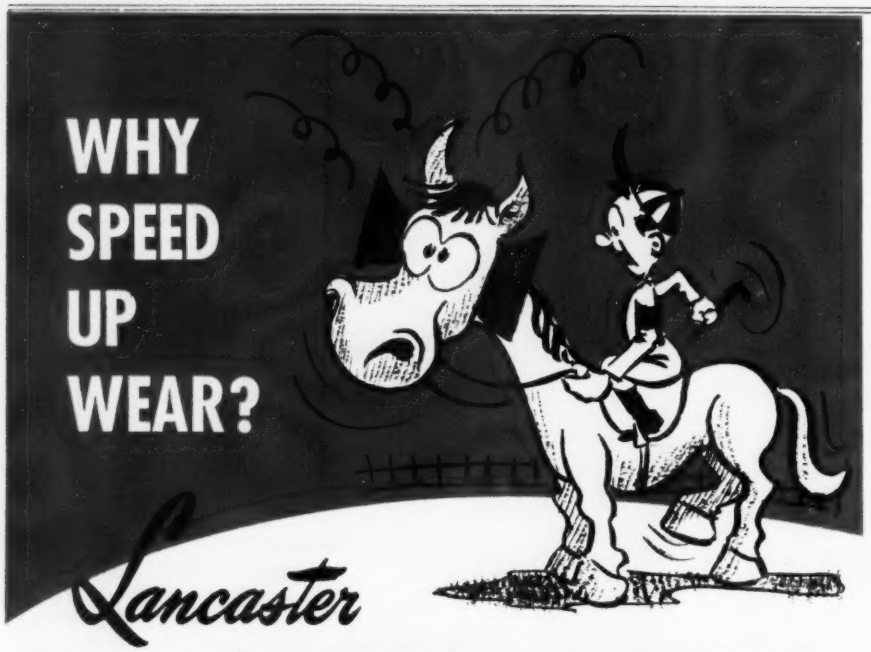


TAP HOLE MICROMETER. New micrometer simplifies measurement of the distance between the center of a pressure tap hole and the face of an orifice plate in orifice meter fittings and flanges. Four calibrated steel plugs sized to fit ¼, ⅜, 7/16 and ½-in. pressure tap holes are mounted on the instrument to permit measurements using various size tap holes without changing the instrument calibration. Operation of the micrometer consists of inserting the proper size plug in the pressure tap hole, aligning the instrument by pressing the block edges flush with the pipe, turning the micrometer barrel until the rod touches the orifice plate, and adding the micrometer reading to the calibration reading — adjacent to the plug — to obtain the distance in thousandths of an inch from the center of the pressure tap hole to the face of the orifice plate.

CIRCLE (67) ON THE REPLY CARD

NEW TWO-WAY RADIO COMMUNICATIONS SYSTEM recently announced by Seiscor Division of Seismograph Service Corp. of Tulsa, is light weight and completely portable. A limited range system for person-to-person communications, it utilizes a transistorized transmitter-receiver unit weighing less than 1 lb, including batteries, and is no bigger than twice the size of a king-size cigarette package in the belt-pack model. Units are available in five standard models — one with the radio unit, batteries, noise-cancelling earphones, and built-in antenna as integral parts of a special plastic safety helmet; another has a noise-cancelling headset with a built-on antenna and noise cancelling microphone, and the unit and batteries in a belt-pack. Two other standard models are similar but with standard earphones and microphones. Fifth standard model is designed for communications under extreme, high level jet engine noise conditions. Units are available for use in 27 megacycle or 42 megacycle operations, with the 27 megacycle units not requiring a license of any kind. Other frequencies available on special order.

CIRCLE (68) ON THE REPLY CARD



non-crack SYNTHETIC DIAPHRAGMS

improve gas meter accuracies
without any changes in index gear ratio
or standard parts

High flexibility, low differentials and superior performance proved in both service and laboratories are built right into Lancaster diaphragms S-7-L (and S-700-L with carrier wire and gaskets attached) for Sprague 1-A Gas Meters.

There's no cloth lining, no fabric failure . . . gas meters can keep operating at the speed they were designed for! No need to hurry up meter wear.

Lancaster's superior synthetic materials are also available in these diaphragms: C-1-L for #1 Ironclad, O-L for #0 Emco and #1-L for #1 Emco Meters.

Increase meter accuracy . . . without increasing meter wear —Order Lancaster Synthetic Diaphragms!

"a meter is only as accurate as its parts"

Lancaster METER PARTS CO.

Manufacturers of Quality Parts for Gas Meters

POST OFFICE BOX 378 LANCASTER, OHIO

CORROSION-RESISTANT TAPE for wrapping joints of plastic-coated steel pipe has been announced by Republic Steel Corp. Called X-Tru-Tape, tape serves to protect exposed ends of X-Tru-Coat steel pipe which is supplied from the mill "cutback" to allow welding. Like the pipe's plastic coat, the tape is resistant to moisture, acids, alkalies, salt, stray currents and corrosive environments. Colored opaque yellow like the coating, the tape reflects heat and makes pipeline immediately noticeable to workmen in areas under construction. Tape offers insulation value of more than 500,000 megohms and a dielectric strength to 15,000 v.

CIRCLE (69) ON THE REPLY CARD

BENDIX RADIO DIVISION has developed a new transistorized two-way radio for cars and trucks similar to the already well-known Bendix "2R" Railroad Radio. Slated to go into production early in 1960, the new unit uses transistors and printed circuits extensively; its power supply is completely transistorized and there are only two tubes in the receiver which were retained to give the "2V" its 0.4 uv sensitivity. Beginning with this model, Bendix is pioneering a program of standardized connectors, in which all subsequent Bendix two-way radio units will use the same rugged type of connector so fleet operators will not have to modify installations for each new type of communications unit. Adaptable to both dash and trunk installation.

CIRCLE (70) ON THE REPLY CARD